Federaal Kenniscentrum voor de Gezondheidszorg
Centre Fédéral d'Expertise des Soins de Santé

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Variaties in de ziekenhuispraktijk bij acuut myocardinfarct in België

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Voorwoord

Tot de jaren '80 beperkte de behandeling van een hartinfarct zich tot het toedienen van zuurstof, sedativa en anti-aritmica en vooral tot monitoring, afwachten en rusten. Pas later bleken eenvoudige farmaca zoals aspirine en beta-blokkers levensreddend te zijn. Ze werden gevolgd door meer revolutionaire behandelingen zoals thrombolyse, ballondilatatie, stents, en, vooral dan in de secundaire preventie, onder meer de statines. Vanuit de ziekenhuiswereld is enthousiast ingespeeld op deze evolutie. Invasieve cardiologie en intensieve zorgen spreken niet alleen tot de verbeelding, maar zijn ook erg duur.

In België worden er in vergelijking met de meeste andere Europese landen, Duitsland met een andere epidemiologie niet te na gesproken, veel coronarografieën en ballondilataties uitgevoerd. [1, 2] Die verschillen kunnen niet verklaard worden door variaties in het voorkomen van hart- en vaatziekten, integendeel. De hamvraag is dan ook of deze dure medische praktijk leidt tot gezondheidswinst voor de patiënt.

Een hartinfarct ligt ons niet alleen letterlijk doch ook emotioneel nauw aan het hart. In de volksmond is een hoog-technologische aanpak met een katheterisatie, ballondilatatie en sinds kort ook de stent ingeburgerd als obligate onderdelen van goede geneeskunde. Méér is daarom niet beter. De huidige wetenschappelijke inzichten relativeren ook de hoogtechnologische aanpak na een infarct. De huidige studie voor België draagt daartoe zijn steentje bij.

De recent nog als dramatisch omschreven uitgavenexplosie in de gezondheidszorg[3, 4] van de afgelopen jaren wordt klassiek toegewezen aan technologische evolutie en demografische wijzigingen. Dat is zeker waar, maar de mogelijkheid dat die snelle kostenstijging kan te wijten zijn aan het feit dat de verkeerde prioriteiten worden gesteld in het gezondheidszorgsysteem en dat in de financiering van (een deel van) de ziekenhuizen majeure incentives werden ingevoerd die niet noodzakelijk leiden tot de meest kosteneffectieve zorg wordt in dat debat zelden overwogen. We hopen dat pleitbezorgers van een verdere uitdijing van het aantal ziekenhuizen met faciliteiten voor invasieve cardiologie dit rapport aandachtig zullen lezen.

Hart- en vaatziekten als meest frequente doodsoorzaak is het domein bij uitstek voor een debat over keuzes in een gezondheidszorg met een onevenwicht tussen niet steeds doelmatige dure en hoogtechnologische onderzoeken en meer causale preventieve behandelingen met een grotere impact op de volksgezondheid.

Een speciaal woord van dank gaat naar het IMA, de Technische Cel en diverse experten. Zonder hun medewerking was deze diepgaande exploitatie van gegevens onmogelijk geweest.

Jean-Pierre CLOSON
Adjunct algemeen directeur

Dirk RAMAEKERS
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Executive summary

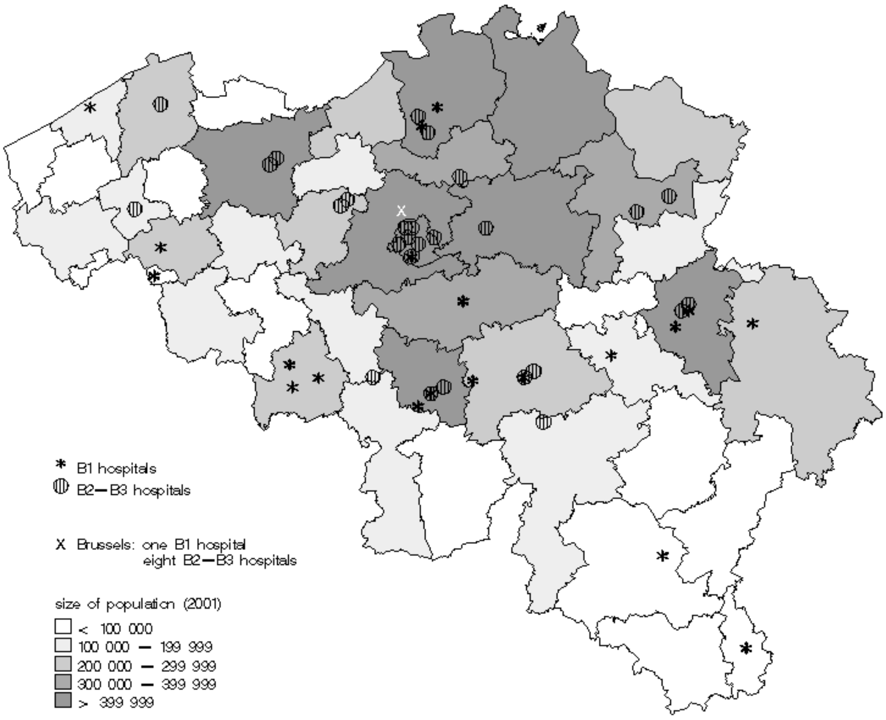
Achtergrond

De behandeling van het acuut myocardinfarct kende revolutionaire veranderingen sinds de jaren ’70. Omdat een hartinfarct veroorzaakt wordt door een gedeeltelijke of een volledige verstopping (thrombose) van een kransslagader beoogt de behandeling het herstel van de bloedstroom doorheen het getroffen bloedvat. De voornaamste behandelopties zijn een onmiddellijke “reperfusie” en/of een latere “revascularisatie”. Urgente reperfusie beoogt om zo snel mogelijk het bloedvat weer open te krijgen door thrombolyse (medicamenteuze behandeling die de verstoppende klonters in het bloedvat oplost) of door een urgente percutane coronaire interventie (PCI) ook wel ballondilatatie (al dan niet in combinatie met stenting) genoemd. Thrombolyse is een redelijk eenvoudige medicamenteuze interventie die in ieder ziekenhuis kan uitgevoerd worden maar PCI vergt een meer gesofisticeerde inrichting met een katheterisatielabo die niet in ieder ziekenhuis aanwezig is. Tijdens de uitvoering van een PCI (urgent of niet) en voor de uitvoering van open heelkunde wordt het vaatbed van het hart in kaart gebracht door middel van een radiografie van de bloedvaten, de zogenaamde coronaire angiografie of coronarografie (CAG). Afhankelijk van de toestand van de patiënt, de aard van het infarct (een infarct met een ST – verhoging op het ECG, STEMI, of een zonder ST- verhoging, NSTEMI) en de tijdsduur verlopen sinds aanvang wordt een urgent herstel van de bloedstroom betracht.

Na het overleven van de acute fase beoogt de behandeling de pompfunctie van het hart te herstellen en/of te behouden en de (hoge) kansen op een recidief infarct te verminderen. Door middel van klinisch onderzoek en enige diagnostische testen wordt het risico bepaald en wordt een patiënt meer of minder intensief opgevolgd, waarbij een eerder goedaardig infarct bij een patiënt met laag risico weinig bijkomende onderzoeken vereist en een kortdurend ziekenhuisverblijf toelaat. Bij patiënten met een hoog risico tracht men met revascularisatie de functionaliteit van het coronaire vaatbed te herstellen, hetzij door open heelkunde (heelkundige myocardrevascularisatie, CABG) hetzij door endovasculaire interventie (electieve of late PCI). Omdat deze interventie electief is, kan de patiënt gemakkelijk overgebracht worden naar een goed uitgerust ziekenhuis.

Bij ontslag is aandacht voor een goede secundaire preventie ter voorkoming van recidieven belangrijk. Deze is gebaseerd op optimaal cardiovasculair risico-management, met adviezen wat betreft de levensstijl (in de eerste plaats vooral stoppen met roken, gewichtsreductie en voldoende bewegen) en medicamenteuze behandeling. De belangrijkste middelen zijn plaatjesremmers (zoals aspirine), β-blokkers, statines en ACE-inhibitoren.

Deze activiteiten spelen zich in België af in een ingewikkeld zorglandschap van ziekenhuizen met vier typen zorgprogramma’s (Zie figuur 1).



Figuur 1: Kaart met de verdeling van B1 en B2-B3 ziekenhuizen. De spreiding is ongelijk, met een groot aanbod in de hoofdstad en in de vallei van Samber en Maas.

A ziekenhuizen zijn de ziekenhuizen in tweede lijn zonder interventionele cardiologie in huis. B1 ziekenhuizen beschikken over een katheterisatielabo voor het uitvoeren van een diagnostische coronaire angiografie (CAG). B2 ziekenhuizen zijn ziekenhuizen in derde lijn met de mogelijkheid tot endovasculaire therapeutische interventies (PCI). De meeste B2 ziekenhuizen beschikken over de capaciteit tot heelkundige myocardrevascularisatie (B3 zorgprogramma) of werken in associatie met een nabijgelegen B3 ziekenhuis zodat we ze gegroepeerd als B2-B3 ziekenhuizen beschouwden.

Door de toegenomen therapeutische opties zijn er dus meer keuze-mogelijkheden, die bovendien een verschillend niveau van technologie vereisen en dus ook verschillend kosten. Richtlijnen helpen cardiologen om de beste diagnostische en therapeutische strategieën te volgen. Het voorliggend project onderzoekt de klinische praktijk van diagnose en behandeling van het acuut hartinfarct in België. Het bepaalt de variatie in klinisch gedrag en de verschillende behandelmodaliteiten en het vergelijkt de resultaten ervan. De in België uitgevoerde diagnostische en therapeutische activiteiten worden vergeleken met de Europese richtlijnen van de European Society of Cardiology die toen geldig waren.

Kernboodschappen

- Thrombolyse en PCI (ballondilatatie) vormen een belangrijke technologische vooruitgang in de behandeling van een acuut myocardinfarct.
- België voerde cardiale zorgprogramma's in waardoor het aantal ziekenhuizen dat PCI mag uitvoeren bij een myocardinfarct beperkt werd. A ziekenhuizen hebben geen katheterisatie-laboratorium. 20 B1 ziekenhuizen mogen diagnostische coronarografieën verrichten; 29 B2 ziekenhuizen kunnen bijkomend PCI uitvoeren. De meeste B2 ziekenhuizen verrichten ook cardiale chirurgie (B2-B3).

Onderzoeksvragen

Welke diagnostische interventies worden uitgevoerd bij welke patiënten in welke ziekenhuizen? Is dit gebruik te verantwoorden op basis van de toen in voege zijnde richtlijnen? Wat is de ligduur, wat zijn de kosten per patiënt in elk zorgprogramma en hoe zijn deze gespreid?

Wat zijn de resultaten qua sterfte binnen de verschillende zorgprogramma's en hebben patiënten die in de acute fase opgenomen werden in een zorgprogramma A, B1 of B2-B3 een even goede prognose? Is het aannemelijk dat duurdere behandelingen ook betere resultaten bieden?

Methoden

De onderzoekspopulatie bestond uit alle opnames voor coronaire hartziekten tussen 1999 en 2001. De jaren 1997 en 1998 werden gebruikt om uit te maken welke patiënten er voordien reeds opgenomen werden voor een cardiovasculaire ziekte. Vervolgens werden in de jaren 1999-2001 alle eerste ('index') opnames voor hartinfarct geïdentificeerd. De verdere ziektegeschiedenis van deze index patiënten werd gevolgd over de maanden 0 en 1 na hun opname (wegens privacy redenen is de exacte datum niet beschikbaar): dit vormt een "episode". Een episode bestaat dus uit een eerste opname (index-opname) voor een acuut infarct en alle verdere opnames (in één of meerdere ziekenhuizen) tot een maximum van vier gedurende maanden 0 en 1 na opname (een variabele periode tussen 29 en 61 dagen).

We beschikten ook via gegevens van de ziekenfondsen over de totale sterfte-gegevens tot december 2003: we konden opvolgen of patiënten overleden in de daaropvolgende periode van minimaal 2 tot maximaal 5 jaar.

We bepaalden de variabiliteit van frequent uitgevoerde diagnostische testen, behandelingen, ligduren en kosten in een groep met laag risico op sterfte en recidief, m.n. patiënten zonder cardiovasculaire voorgeschiedenis, zonder diabetes, jonger dan 75 jaar en levend ontslagen. We vergeleken dit met de adviezen van de ESC-richtlijnen van 1996. We deden dit naar zorgprogramma, waarbij B2 en B3 geaggregeerd bleven tot één groep. Voor de diagnostische testen definieerden we een consumptie-index waarbij testen een verschillend gewicht toegekend kregen naargelang ze meer klinisch nut hadden en in meer ziekenhuizen bij meer patiënten verricht werden.

We vergeleken de mortaliteit naar zorgprogramma van index-opnames voor alle patiënten. Verschillen in kortetermijnssterfte werden bepaald met behulp van logistische regressie, lange termijnssterfte met behulp van Cox proportional hazards, na correctie voor leeftijd, geslacht, diabetes en cardiovasculaire voorgeschiedenis.

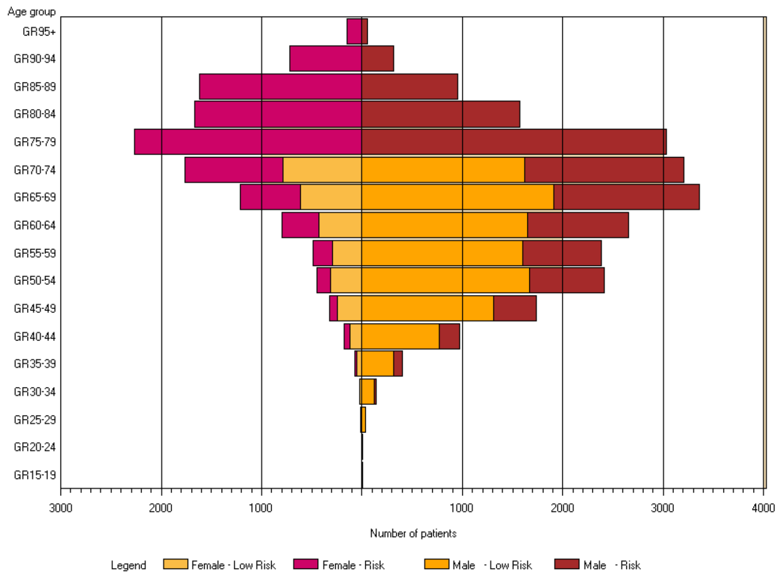
Kernboodschappen

- **Alle patiënten die in 1999, 2000 en 2001 met een myocardinfarct zijn opgenomen in een Belgisch ziekenhuis maken deel uit van de studie.**
- **Dit project onderzoekt de variaties in het gebruik van diagnostische testen, behandelingen en resultaten in de Belgische ziekenhuizen van de verschillende zorgprogramma's.**
- **Een patiëntengroep met laag risico laat vergelijkingen toe onderling tussen de zorgprogramma's en met Europese richtlijnen.**

Resultaten

Beschrijving van de totale onderzoekspopulatie.

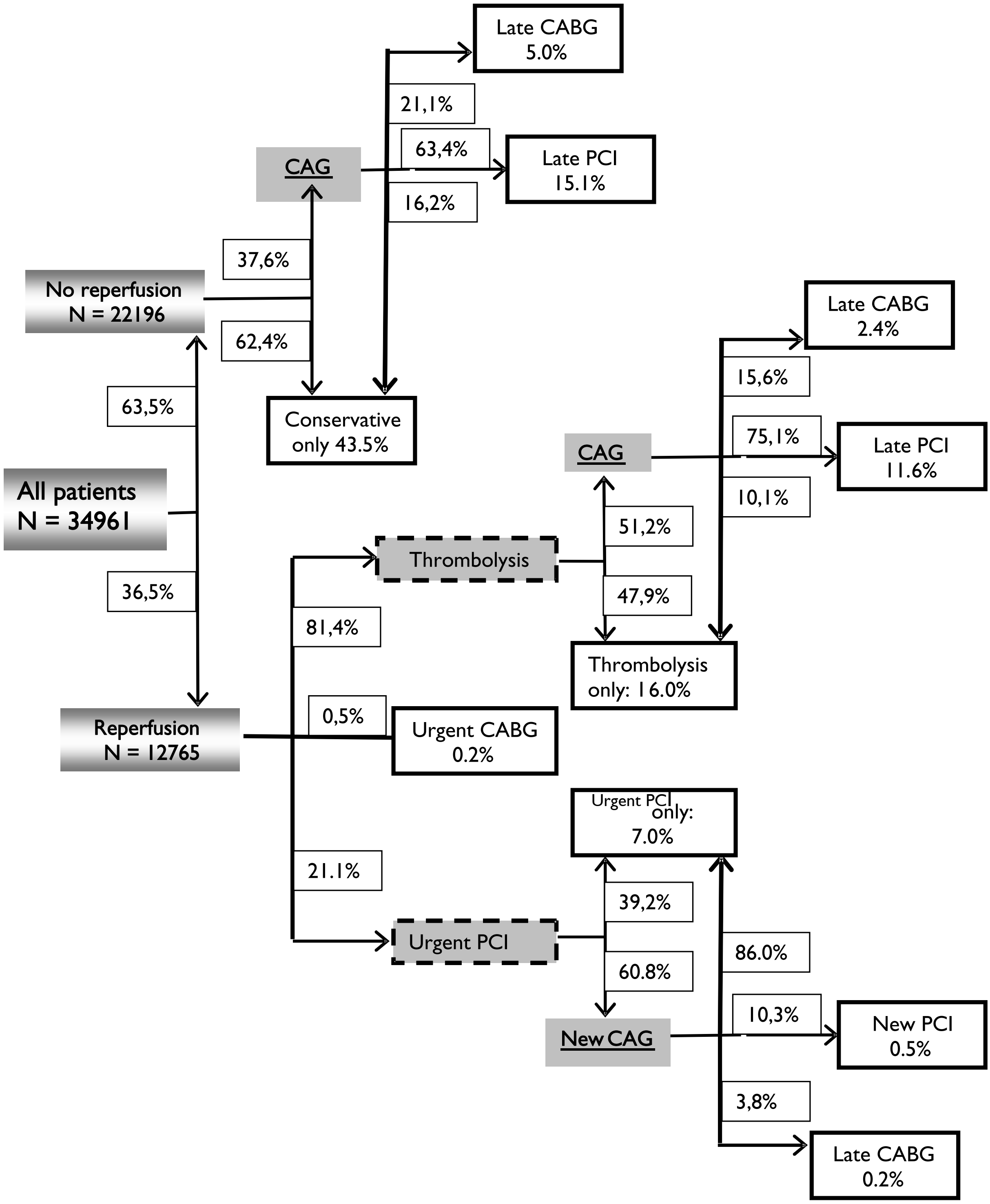
We verzamelden gegevens over 53291 verblijven bij 34961 patiënten.



Figuur 2: Demografie van infarctpatiënten met laag en hoog risico. Noteer het grote verschil tussen mannen en vrouwen.

63,4% van de patiënten werd éénmaal opgenomen, 23,3% tweemaal, 10,8% driemaal en 2,5% viermaal tijdens de episode. De incidentie van index-opnames was 114 per 100 000 persoonsjaren. De regionale spreiding is consistent met de hogere sterfte aan coronaire hartziekten in het bekken van Samber en Maas en in Limburg.

2 op 3 (66,44) waren mannen van gemiddeld 64,7 jaar oud en 1 op 3 waren vrouwen, die gemiddeld 9,2 jaar ouder waren (73,9 jaar). 20,3 % van de patiënten hadden een detecteerbare cardiovasculaire voorgeschiedenis en 24,8% hadden diabetes.



Figuur 3 Behandeling na een infarct. 43.5% worden uitsluitend conservatief behandeld, 16% krijgen uitsluitend thrombolyse, 34,2% kregen een PCI en 7.8% kregen een CABG. Door multipele behandelingen kunnen aantallen optellen tot meer dan 100%.

Van de 34961 indexopnames werden 36,5 % gereperfuseerd. 29,7% kreeg thrombolyse en 7,7% kreeg een urgente PCI (zie figuur 3). 63,5 % werd niet gereperfuseerd. 23,9% werd na niet-reperfusie onderzocht met een CAG, van hen werd 85% gerevasculariseerd met een electieve PCI of een CABG. De globale fracties reperfusie en revascularisatie zijn goed vergelijkbaar met vergelijkbare West-Europese landen.

Reperfusie of revascularisatie toonde een opvallende leeftijdsgradiënt, 48% van de jongere (<60 jaar) patiënten werd gereperfuseerd en 58% van deze leeftijdsgroep werd gerevasculariseerd. Dit fenomeen wordt de "treatment-risk" paradox genoemd: het is contra-intuïtief maar toch zinvoller om oudere patiënten met hogere risico's te behandelen dan jongeren met lage risico's.

Beschrijving van de populatie en behandeling naar zorgprogramma

Patiënten met index-opnames in A zijn één jaar ouder, in B2-B3 ziekenhuizen één jaar jonger dan het gemiddelde. Er zijn ook iets meer mannen in B2-B3 ziekenhuizen (67,8% vs. 66,4%). Er waren verder geen grote verschillen aantoonbaar tussen de patiëntenpopulaties naar zorgprogramma. De behandeling verschilde door het verschillende aanbod. Het is opmerkelijk dat er ongeveer evenveel patiënten werden gereperfuseerd tijdens de eerste opname in een A, B1 of B2-B3 ziekenhuis; in B2-B3 ziekenhuizen werd meer urgente PCI uitgevoerd maar minder thrombolyse.

Op het einde van de episode waren meer patiënten met index-opnames in B2-B3 ziekenhuizen gerevasculariseerd. Er was weinig verschil voor CABG (een interventie waartoe minder vlot beslist wordt), maar in B2-B3 ziekenhuizen sloten 46,6% van de patiënten de episode af met een PCI tegenover respectievelijk 25,1% en 25,6% in A en B1 ziekenhuizen. Dit is vermoedelijk een gevolg van "supply induced demand": het is er, dus het wordt uitgevoerd. Zo ook kreeg 55% van wie eerst opgenomen werd in een B2-B3 ziekenhuis een CAG gedurende de episode, tegenover respectievelijk 30% en 36%. De meeste patiënten die een CAG ondergingen werden naderhand gerevasculariseerd.

Het is opmerkelijk dat het aantal patiënten dat het ziekenhuis verliet met een β-blokker ongeveer gelijk was in de drie zorgprogramma's (tussen 68,4% en 71.0%). Dat is een indicator van goede kwaliteit.

Kernboodschappen

- **Op bijna 35000 eerste opnames voor myocardinfarct werd bij iets meer dan één derde een behandeling gegeven om de bloedtoevoer te herstellen door thrombolyse of PCI.**
- **Jongere patiënten met een lager risico worden in verhouding meer behandeld dan oudere patiënten met een hoger risico.**
- **De patiëntenpopulaties in de verschillende zorgprogramma's zijn onderling vergelijkbaar. Patiënten eerst opgenomen in een B2-B3 ziekenhuis, krijgen vaker een PCI (urgent en electief) dan patiënten eerst opgenomen in een A of B1 ziekenhuis.**

Variatie in diagnostisch en therapeutisch gedrag

Dit onderzoek werd uitgevoerd op de subgroep van patiënten met een laag risico. Er zijn op basis van de beschikbare gegevens geen aanzienlijke verschillen in prognostische determinanten tussen de patiënten in de drie soorten zorgprogramma's (A, B1 en B2-B3). De gemiddelde leeftijd was 58,5 jaar, 79,2% waren mannen, niemand had diabetes of een cardiovasculaire voorgeschiedenis. Er was geen verschil in het gebruik van hoge doses diuretica (proxy voor pompfalen) of inotropica (proxy voor cardiogene shock). A ziekenhuizen noteerden per patiënt 3 secundaire diagnosen tegenover 4,7 en 4,6 in B1 en B2-B3 ziekenhuizen. De betrouwbaarheid van de codering van de secundaire diagnosen is onduidelijk en was erg variabel tussen de ziekenhuizen.

Variatie in behandeling

Van deze laag risico-groep werd 48% gereperfuseerd gedurende de eerste, acute opname, met nauwelijks verschillen tussen A, B1 of B2-B3 ziekenhuizen; B2-B3 ziekenhuizen doen meer urgente PCI, maar minder thrombolyse. Daarentegen waren er grote verschillen in CAG en revascularisatie tussen de B2-B3 ziekenhuizen en de andere zorgprogramma's na afloop van de hele ziekte-episode. Patiënten die eerst in een B2-B3 ziekenhuizen werden opgenomen kregen in 76.7% van de gevallen minstens één CAG, in een A of B1 ziekenhuis was dit respectievelijk 54.5% en 57.2%. 70.2% van de patiënten in B2-B3 ziekenhuizen werden gerevasculariseerd, tegenover respectievelijk 50% en 48% in de A en B1 ziekenhuizen. Deze verschillen zijn klinisch niet verklaarbaar, gezien revascularisatie de hele episode beschrijft inclusief transferts naar de meer geoutilleerde B2/B3 ziekenhuizen. De verklaring wordt geleverd door het mechanisme van de "supply induced demand", waarbij B2-B3 ziekenhuizen meer interventies doen omdat ze zelf de middelen in huis hebben en ook daartoe gefinancieerd worden.

Van de patiënten eerst opgenomen in een A ziekenhuis werd 57,5% voor een tweede maal opgenomen in een B2-B3 ziekenhuis, voor B1 ziekenhuizen was dat 47,6%: B1 ziekenhuizen verwijzen dus minder vaak. Van de patiënten eerst opgenomen in een A ziekenhuis werd 8,6% voor een tweede maal opgenomen in een A of B1 ziekenhuis gedurende de episode. Voor B1 ziekenhuizen was dat 10,4%. Sommige ziekenhuizen verwijzen weinig, andere ziekenhuizen verwijzen ongepast. Eén A ziekenhuis verwees nagenoeg iedereen naar een B1 ziekenhuis.

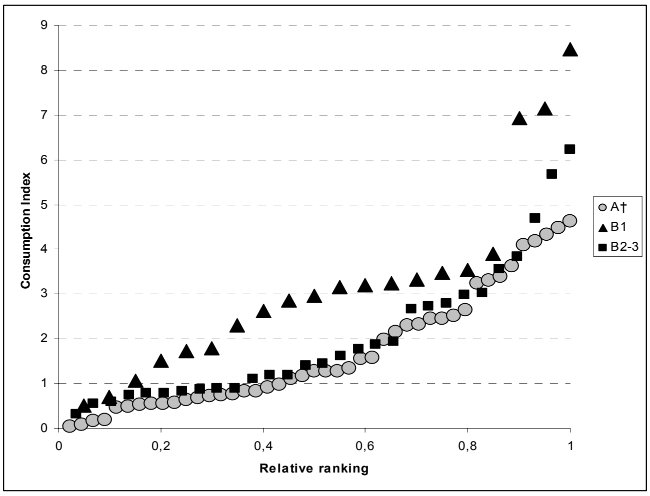
In B2-B3 ziekenhuizen was er ook een zeer groot verschil in aantallen verwezen patiënten. Van de 29 B2-B3 ziekenhuizen functioneerden 12 ziekenhuizen als een referentiecentrum, met meer dan 200 verwijzingen uit de laag risico-groep; 11 B2-B3 ziekenhuizen trokken geen of nauwelijks patiënten aan uit andere ziekenhuizen.

Variatie in niet-invasieve diagnostiek

Testen met hoog klinisch nut vinden we bovenaan de consumptie-index terug, waarbij veel ziekenhuizen deze testen toepassen bij veel patiënten. Testen zonder veel aanwijsbaar nut worden daarentegen minder en meer variabel uitgevoerd. In een deel van de ziekenhuizen worden deze testen zelden tot nooit uitgevoerd, terwijl een ander deel deze testen frequent gebruikt. De B1 ziekenhuizen tonen het meest irrationeel gebruik. Vectorcardiografie was een verouderde techniek zonder bekend nut, opgenomen in geen enkele richtlijn. 83% van de B2-B3 ziekenhuizen voerden 2.2 vectorcardiografieën uit bij 23% van de patiënten, 85% van de B1 ziekenhuizen voerden 3.1 vectorcardiografieën bij 35% van de patiënten. Farmacodynamische ECG testen zijn zelden geïndiceerd. Alle B2-B3 ziekenhuizen voerden 1.4 testen uit bij 18% van de patiënten, 85% van de B1 ziekenhuizen voerden 1.9 testen uit bij 33% van de patiënten.

Met tien verschillende niet- of weinig invasieve testen met dubieus klinisch nut of meer zeldzame indicatie werd een consumptie-index opgesteld. Het mediane gebruik (met het interkwartiele bereik, IQR, zijnde de middenste helft van de ziekenhuizen tussen het 25ste en 75ste percent) van A-ziekenhuizen was 1.3 (IQR 0.8-2.3), van de B1 ziekenhuizen 3.1 (IQR 1.8-3.5) en bij de B2-B3 ziekenhuizen 1.5 (IQR 0.9 – 2.8). Dit bevestigt een patroon van ongepast gebruik in B1-zorgprogramma's.

Bij de relatieve rangordening van een algemene consumptie-index verbruikte ieder B1 ziekenhuis steeds meer dan een A of B2 ziekenhuis van een zelfde rangorde (dat wil zeggen dat mindere gebruikers bij B1 toch meer gebruiken dan mindere gebruikers bij A of B2-B3).



Figuur 4 Verdeling van de ziekenhuizen naar consumptie-index (gerangschikt van laag naar hoog, enkel patiënten met laag risico). B1-ziekenhuizen verbruiken op alle niveaus steeds meer dan B2-B3 of A-ziekenhuizen. Drie B1 ziekenhuizen verbruiken erg veel.

Variatie in ligduur

De mediane duur van het eerste verblijf was 8 dagen (IQR 5-11), het tweede 2 dagen (IQR 2-5). In een episode met één enkel verblijf waren de mediane ligduren 9 (A), 10 (B1) en 8 (B2-B3). Gedurende de hele episode was de mediane ligduur 10 dagen (IQR 7-14). Vrouwen en ouderen verbleven gemiddeld langer (per 10 jaar leeftijd komt er ongeveer een dag bij). Patiënten die eerst werden opgenomen in A en B1 ziekenhuizen verbleven gedurende een mediane ligduur van 11 dagen (IQR 8-15) in het ziekenhuis. In B2-B3 ziekenhuizen was dit 9 dagen (IQR 6-12).

De internationale richtlijnen bevelen ontslag aan binnen de vier dagen voor een ongecompliceerd infarct met laag risico, waartoe ongeveer de helft van de patiënten behoort. In de door ons geselecteerde groep met zeer laag risico (zonder diuretica, inotropica of CABG) werd gemiddeld 8 % ontslagen binnen de vier dagen (gehele episode), zoals aangeraden door de richtlijnen.

De variatie van ligduren tussen ziekenhuizen bleek beperkt: de meeste variatie wordt veroorzaakt door variatie tussen patiënten, niet tussen ziekenhuizen.

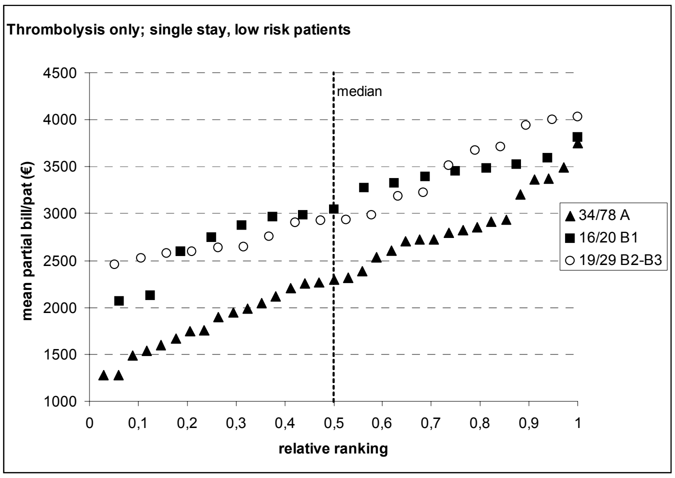
Variatie in kosten

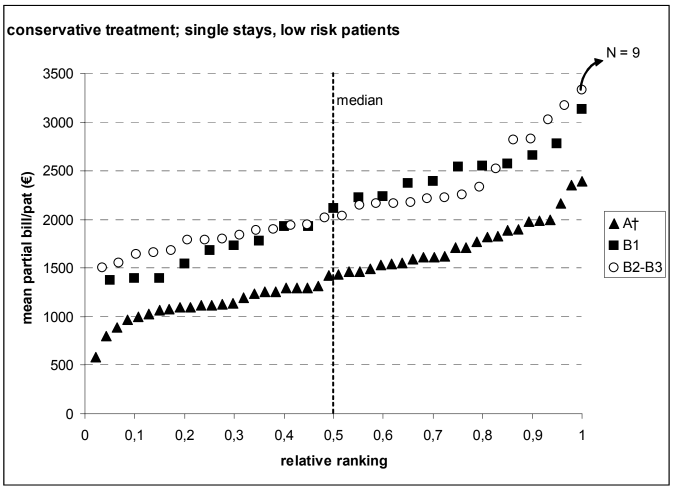
Kosten worden samengesteld door de kosten van de ligduur (de verblijfskosten) en de kosten van de uitgevoerde diagnostiek en behandelingen. Verder bespreken we enkel de kosten van diagnostiek en behandelingen ("partial bill"). Om de totale kost van een infarctpatiënt te berekenen moet de ligdag kost erbij geteld worden. De vernoemde kosten zijn de gemiddelde kostprijs van een patiënt per ziekenhuis. De variatie is dus de variatie tussen ziekenhuizen, niet patiënten. Het betreft steeds laag risico patiënten.

De mediane factuur voor *conservatief* behandelde laag risico patiënten bedraagt 1440 € (IQR 1120 €-1720 €) in A ziekenhuizen, 2170 € (IQR 1700-2550) in B1 ziekenhuizen en 2030 € (IQR 1800-2240) in B2-B3 ziekenhuizen. De mediane factuur voor met *thrombolyse* behandelde laag risico patiënten bedraagt 2310 € (IQR 1900 €-2830 €) in A ziekenhuizen, 3610 € (IQR 2810-3470) in B1 ziekenhuizen en 2940 € (IQR 2630-3670) in B2-B3 ziekenhuizen. Dezelfde behandeling is steeds 700 tot 800 € per patiënt goedkoper in A ziekenhuizen.

Patiënten die doorverwezen werden naar B2-B3 ziekenhuizen kostten mediaan 2120 € (IQR 1760 – 2900) (in een A-ziekenhuis) en 2540 € (in een B1 ziekenhuis).

Patiënten die een *urgente PCI* kregen kostten mediaan 5850 € (IQR 5130 – 6540), die een *electieve PCI* kregen, 5820 € (IQR 4950 – 6760). De mediane rekening voor een *CABG* bedroeg 9350 € (IQR 8380 – 10360) ; de totale factuur, samen met de verblijfskosten, bedraagt dan 14620 € gezien de ligduur bij CABG ook langer is.





Figuur 5 a en 5b. Kosten van dezelfde behandeling in de drie zorgprogramma's (patiënten met laag risico, een enkel verblijf in een enkel ziekenhuis). De ziekenhuizen werden gerangschikt van laag naar hoog. Er is geen dwingende medische reden waarom de behandeling van deze patiënten duurder is in B1 of B2-B3 ziekenhuizen.

Kernboodschappen

- Variaties in medisch gedrag werden bestudeerd op de laag risico groep. Ongeveer de helft van de patiënten in alle zorgprogramma's krijgt een behandeling om de bloedtoevoer te herstellen met voornamelijk thrombolyse in A en B1 en meer urgente PCI in B2-B3.
- In B2-B3 ziekenhuizen krijgen meer patiënten die daar eerst opgenomen werden een revascularisatie dan patiënten die eerst opgenomen werden in A of B1.
- Er is een grote variatie in het gebruik van diagnostische testen. Het overgebruik van testen met zelden of weinig klinisch nut is het meest uitgesproken in de B1 ziekenhuizen.
- B1 en B2-B3 ziekenhuizen zijn voor conservatief of met thrombolyse behandelde patiënten duurder dan A ziekenhuizen.

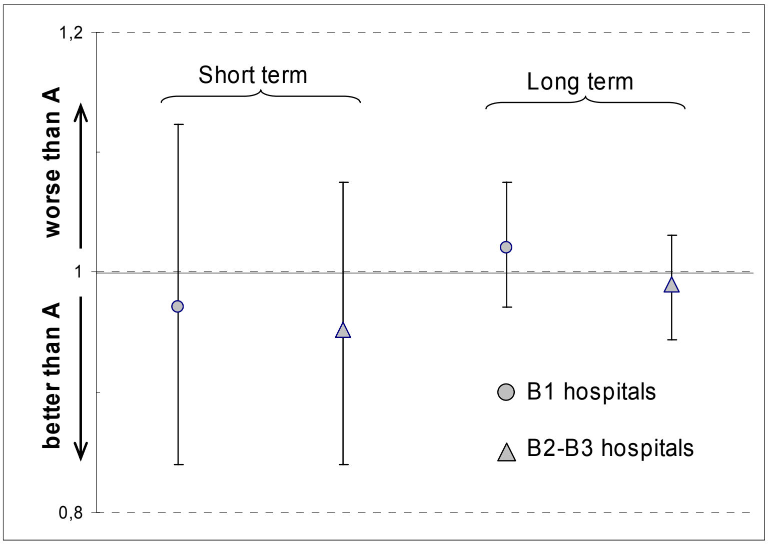
Sterfte na een myocardinfarct

Behandelingen beogen om patiënten een langer leven met een betere levenskwaliteit te bieden. In deze analyse bestudeerden we enkel de totale sterfte naar episode (korte termijn) en naar follow-up (2 tot 5 jaar). Hier bestuderen we weer de hele groep infarctpatiënten en niet een selectie met laag risico. De absolute cijfers zeggen niet zoveel over de letaliteit van een infarct: slechts een fractie van de infarctpatiënten sterft in het ziekenhuis. Het merendeel sterft er buiten.

5,2 % sterft de eerste dag, 15,5 % sterven gedurende de episode (één tot twee maanden na index opname), 22,1 % sterven het eerste jaar en 26,1% sterven het tweede jaar. Noteer dat de gemiddelde leeftijd 68 jaar is, en dat ook zonder infarct de sterfte flink begint toe te nemen op deze leeftijd.

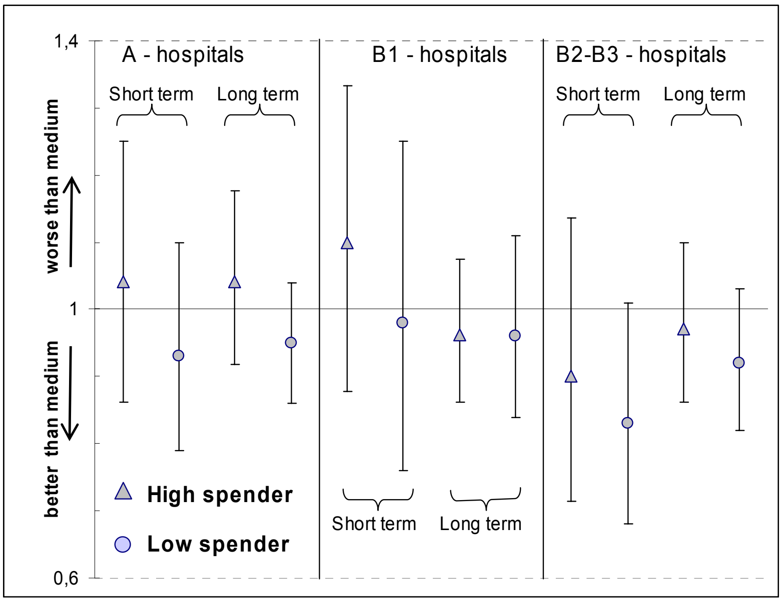
Leeftijd is een belangrijke determinant van korte termijnsterfte. Bij patiënten die 10 jaar ouder zijn dan het gemiddelde, overlijdt 28% binnen de episode, indien 10 jaar jonger overlijdt 8,6%. Vrouwen hebben een slechtere prognose. De korte termijnsterfte bij mannen was 12.2%, bij vrouwen 21.1%. De prognose bij vrouwen blijft slechter na correctie voor hun hogere leeftijd (odds ratio 1.12). Dit betekent dat als de sterfte 15,5% is bij mannen, deze bij vrouwen met vergelijkbare karakeristieken 17% is. Bij diabetici en mensen met een cardiovasculaire voorgeschiedenis zou de sterfte dan 18,3 % zijn. De vijfjaarsoverleving na een infarct was 63%.

De kortetermijnsterfte in B2-B3 ziekenhuizen is relatief 5% (95% betrouwbaarheidsinterval -7%, +19%) lager dan in A ziekenhuizen en 3% (95% BI -11%; +19%) lager dan in B1 ziekenhuizen. Er is met andere woorden geen aantoonbaar verschil: de statistische precisie is laag. Over de langere termijn zijn de sterfteverschillen nog lager: het sterftecijfer (hazard ratio) is nog 1% hoger in A ziekenhuizen dan in B2-B3 ziekenhuizen en 2% lager dan in B1 ziekenhuizen.



Figuur 6a: Prognose, uitgedrukt als short term odds ratio's en long term hazard ratio's op totale sterfte, van een eerste opname in B1 of B2-B3 ziekenhuizen vergeleken met A ziekenhuizen (referentie = 1.0). De foutenbalken tonen het 95% betrouwbaarheidsinterval. Er is geen aantoonbaar verschil in prognose tussen de verschillende zorgprogramma's.

Tot slot hebben we ook getest of duurdere behandelingen "beter" waren, d.i. resulteerden in een langere overleving. Ziekenhuizen werden ingedeeld naar zorgprogramma in goedkoop (<25%), duur (>75%) en gemiddeld (de overige helft). De resultaten toonden geen statistisch betekenisvolle verschillen. In elk geval kon nergens een aanduiding gevonden worden dat ziekenhuizen met duurdere zorgtrajecten betere resultaten naar sterfte toe boekten.



Figuur 6b Prognose, uitgedrukt als odds ratio's en hazard ratio's op totale sterfte, na opname in dure ziekenhuizen (high spenders, het duurste kwart) en goedkope ziekenhuizen (low spenders, het goedkoopste kwart) naar zorgprogramma, vergeleken met gemiddelde verbruikers (de andere helft, referentie = 1.0). De foutenbalken tonen het 95% betrouwbaarheidsinterval. Goedkopere ziekenhuizen hadden nooit een slechtere prognose.

Kernboodschappen

- **De korte en de langetermijnssterfte zijn niet verschillend tussen de verschillende types van zorgprogramma's.**
- **De sterfte bij patiënten eerst opgenomen in duurdere ziekenhuizen is niet lager dan bij patiënten eerst opgenomen in goedkopere ziekenhuizen.**

Conclusies en aanbevelingen

Dit rapport toont aanzienlijke variatie in diagnostisch en therapeutisch handelen tussen ziekenhuizen en zorgprogramma's en daardoor ook een aanzienlijke variatie in kosten per infarctpatiënt. Er was geen variatie in sterfte naar zorgprogramma. Patiënten die initieel opgenomen werden in een A-ziekenhuis, een B1-ziekenhuis of een B2-B3 ziekenhuis hadden een gelijkaardige prognose. Na een index-opname in een A ziekenhuis kon de patiënt ten allen tijde verwezen worden voor interventie indien dit nodig geacht werd. Patiënten met een eerste opname in B1 of in B2-B3 ziekenhuizen kostten meer dan patiënten met een eerste opname in A ziekenhuizen. Omdat B2-B3 ziekenhuizen tertiaire referentie-ziekenhuizen zijn, is dat verschil verklaarbaar door een hoger aanbod van hoogtechnologische zorg. Intermediaire B1-ziekenhuizen hebben geen interventionele cardiologie, maar gebruikten meer testen met klinisch onduidelijk of zeldzaam nut.

Bij vergelijking en interpretatie van deze gegevens moeten de beperkingen ervan goed voor ogen gehouden worden. Administratieve gegevens zijn niet verzameld met epidemiologische doeleinden. Ze bevatten beperkte klinische gegevens en zijn met wisselende kwaliteit ingevuld. We konden geen onderscheid maken tussen STEMI en NSTEMI infarcten en we konden niet corrigeren voor de ernst van het infarct. We hebben geen gegevens over roken, obesitas of andere risicofactoren. We konden wel corrigeren voor geslacht, leeftijd, aanwezigheid van een cardiovasculaire voorgeschiedenis of diabetes. We konden de sterfte opvolgen en nagaan of patiënten behandeld waren voor pompfalen (behandeling met hogere doses diuretica en/of met inotropica).

Om de resultaten te kunnen interpreteren, moeten we aannemen dat de patiënten met een eerste opname in een A-ziekenhuis, een B1-ziekenhuis of een B2-B3 ziekenhuis redelijk vergelijkbaar zijn. Deze aanname betreft een "counterfactual experiment", waarbij de afstand tot het dichtstbijzijnde ziekenhuis bepaalt waar een patiënt terecht komt, onafhankelijk van de aard van zijn aandoening. We beseffen dat dit niet altijd zo is. Sommige index-opnames in B2-B3 ziekenhuizen betreffen doorverwezen patiënten, waarbij de patiënten minder dan één nacht in het verwijzende ziekenhuis verbleven: dat ziekenhuis wordt dan niet geregisteerd als index-ziekenhuis. Dat betekent daarom echter niet dat B2-B3 ziekenhuizen een ernstiger case mix vertonen. De 'treatment-risk' paradox toont dat jongere, gezondere patiënten preferentieel behandeld worden. Dit effect vinden we weer in de rechtstreekse vergelijking tussen A en B2-B3 ziekenhuizen, waarbij patiënten in het A zorgprogramma aanwijsbaar ouder (+ 2 jaar) en vrouwelijker (+ 2%) zijn. Vrouwen hebben een slechtere prognose in het ziekenhuis. Op de bekende indicatoren geslacht en leeftijd hebben patiënten in A-ziekenhuizen dus eerder een minder goede prognose.

Patiënten in A ziekenhuizen hadden minder secundaire diagnosen gecodeerd dan in B1 en B2-B3 ziekenhuizen. Maar aan het kundig coderen van secundaire diagnosen is een financiële aansporing verbonden: de forfaitaire ziekenhuisfinanciering wordt er gedeeltelijk mee berekend. De alternatieve hypothese is daarom dat B1 en B2-B3 ziekenhuizen efficiënter dan A-ziekenhuizen secundaire diagnosen kunnen coderen.

In een efficiënte zorgorganisatie worden twee niveau's van ziekenhuiszorg voorzien: secundaire en tertiaire ziekenhuizen. Het secundaire niveau verzorgt de algemene opvang en verwijst patiënten voor hoogtechnologische zorg door naar het tertiaire niveau. "Tussenechelons" zijn inefficiënt, omdat ze het aantal doorverwijzingen vermeerderen. Het tussenechelon, bevoegd voor een beperkt pakket, valt tussen wal en schip. In de Belgische hartzorg zijn vier niveaus te onderscheiden. Het niveau B1 biedt enkel coronaire angiografie aan. Doorverwijzen van A naar B1 heeft weinig zin: coronaire angiografie zonder mogelijkheid tot endovasculaire interventie betekent een extra belasting voor de patiënt bij wie een angioplastie noodzakelijk blijkt. Voor meer inzet van middelen loopt de patiënt dus meer risico's. Dit is geen wenselijke situatie. Het niveau B2 biedt wel interventionele cardiologie aan, maar niet steeds cardiale chirurgie. Indien tijdens een endovasculaire interventie problemen ontstaan die een urgente heelkundige interventie noodzaken, moet de patiënt alsnog doorverwezen worden naar een hoger echelon. Dit is evenmin wenselijk.

In een efficiënt zorgsysteem wordt de regionale spreiding van referentie-ziekenhuizen bepaald door de bevolkingsdichtheid en de transportverbindingen tussen de centra. In België is de regionale spreiding niet optimaal, met een groot overaanbod van tertiaire ziekenhuizen in de hoofdstad en een groot aanbod in de valleien van Samber en Maas.

Dit rapport heeft voor de tertiaire ziekenhuizen ook een "supply induced demand" kunnen aantonen. Hoogtechnologische zorg is duurder voor een beperkte toename in de effectiviteit: een gevolg van de economische wet van de verminderende meeropbrengst. Dit onderzoek kon geen verschillen in sterfte identificeren tussen het secundaire of tertiaire echelon.

Kernboodschappen

- **Er zijn geen aanwijzingen dat er aanzienlijke verschillen waren in case mix tussen de patiënten met index-opname in A, B1 of B2-B3. De enige aantoonbare verschillen waren beperkt, in het nadeel van A ziekenhuizen en consistent met de treatment-risk paradox.**
- **Er was geen verschil in sterfte aantoonbaar tussen patiënten eerst opgenomen in A, B1 of B2-B3 ziekenhuizen of tussen 'dure' en 'goedkope' zorgtrajecten voor vergelijkbare patiënten in deze zorgprogramma's.**
- **Een index opname in een B2-B3 ziekenhuis kost meer dan in een A-ziekenhuis voor een vergelijkbare patiënt. Dit wordt verklaard door 'supply induced demand'.**

Uit dit onderzoek inzake medische praktijk en kosten bij patiënten met een myocardinfarct volgen een reeks conclusies en aanbevelingen die nuttig zijn voor de beleidsmakers.

- De resultaten van deze studie liggen in de lijn van de wetenschappelijke vaststellingen die de superioriteit van primaire PCI (ballondilatatie) ten opzichte van thrombolyse in de acute behandeling van een acuut myocardinfarct nuanceren. Opvallend is bovendien het grote aantal (controle) coronarografieën en late, geplande ballondilataties bij patiënten die een hartinfarct doormaakten. Er zijn geen aanduidingen dat het (hoge) aantal PCI-centra (B2) niet volstaat om aan de nodige interventies voor de gepaste indicaties te voldoen in België. Er is een grote concentratie van ziekenhuizen met zorgprogramma B2 in het centrum van het land. Enkele meer afgelegen perifere plaatsen vergen een oplossing. Vanuit een beleid gericht op billijkheid en doelmatig gebruik der middelen dient er voor de organisatie van de faciliteiten voor interventionele cardiologie op de eerste plaats rekening gehouden te worden met objectieve criteria zoals bevolkingsdichtheid en geografische toegankelijkheid en een uniforme toepassing ervan. Vermeerdering van het aantal tertiaire ziekenhuizen verhoogt het comfort van de door hen bediende bevolking voor electieve interventies, Meer tertiaire ziekenhuizen verhogen anderzijds zeker de kosten, terwijl de baten (bij voldoende aanbod) minstens onzeker zijn. Het kan daardoor in conflict komen met het aanbieden van meer, maar ook duurdere effectieve medische technologie (bv. drug eluting stents).

- De wetenschappelijke literatuur en resultaten van andere registraties wijzen op een verband tussen het volume en het behaalde resultaat van interventionele cardiologie. De huidige MKG registratie omvat onvoldoende klinische gegevens. We bevelen het verder ontwikkelen van een verplichte registratie voor de indicatie en het resultaat van alle invasieve procedures aan. Dit dient te geschieden in nauw overleg tussen cardiologen en beleidsverantwoordelijken.

- Er is weinig medische meerwaarde voor het bestaan van louter diagnostische invasieve centra (B1): zij bieden voor de zorg van patiënten met een acuut infarct geen meerwaarde in vergelijking met een A centrum en ze kosten meer. Vanuit patiëntenstandpunt is het ook moeilijk verdedigbaar dat een patiënt twee keer een interventie moet ondergaan waar het ook in één keer kan: de eerste maal om het letsel te visualiseren (B1) gevolgd door een nieuwe katheterisatie enkele dagen later voor behandeling (B2). Dit rapport beveelt daarom aan terug te keren naar een efficiënt en transparant systeem met twee niveau's van secundaire en tertiaire zorg.

- De grote variabiliteit in het gebruik van diagnostische onderzoeken kan niet verklaard worden vanuit het goede gebruik van praktijkrichtlijnen noch door de patiëntenkarakteristieken, zoals overtuigend aangetoond in deze studie. Feedback en auditing zijn de logische en in de regelgeving van de ziekteverzekering voorziene stappen. De huidige financiering van de cardiologie zet aan tot een 'supply induced demand'. De beleidsverantwoordelijken dienen zich te bezinnen over een aangepaste financiering met het oog op het meest doelmatig gebruik van de middelen.

Scientific summary: Contents

Glossary/Acronyms

- ACC: American College of Cardiology
- ACE: Angiotensin Converting Enzyme
- ACS: Acute Coronary Syndrome
- AHA: American Heart Association
- AMI : Acute Myocardial Infarction
- ASA: Acetyl Salicylic Acid
- BB: Beta-Blocker
- CABG : Coronary Artery Bypass Grafting
- CAD: Coronary Artery Disease
- CAG : Coronary Angiography
- CCP: Cardiac Care Program
- GUSTO : Global Utilization of Streptokinase and Tissue Plasminogen Activator for Occluded Coronary Arteries
- ECG: Electrocardiogram
- EF: Ejection fraction
- ESC: European Society of Cardiology
- GIIbIIIa: Glycoprotein receptor IIbIIIa inhibitor
- ICER: Incremental Cost-Effectiveness Ratio
- IHD: Ischemic Heart Disease
- IRA: Infarct Related Artery
- LAD: Left Anterior Descending artery
- LMWH: Low Molecular Weight Heparin
- LOE: Length of Episode
- LOS: Length of Stay
- LV: Left Ventricle, Left Ventricular
- MI: Myocardial Infarction
- MCD: Minimum Clinical Data (RCM/MKG)
- MFD: Minimum Financial Data (RFM/MFG)
- NSTE-ACS: Non ST-Elevation Acute Coronary Syndrome
- NSTEMI: Non ST-Elevation Myocardial Infarction
- PCI : Percutaneous Coronary Intervention
- P-PCI: Primary Percutaneous Coronary Intervention
- PTCA: Percutaneous Transluminal Coronary Angioplasty
- QALY: Quality-Adjusted Life-Year
- STE-ACS: ST-Elevation Acute Coronary Syndrome
- STEMI: ST-Elevation Myocardial Infarction
- TEE: Transoesophageal Echocardiography

- TL: Thrombolysis, Thrombolytics
- tPA: tissue-type Plasminogen Activator
- UA: Unstable Angina

1. INTRODUCTION: CONTEXT AND STUDY OBJECTIVES

The treatment of acute myocardial infarction (AMI) revolutionised in the 80ies. After thrombolysis, primary percutaneous coronary interventions (PCI) and coronary artery stenting were introduced. Recently, evolving technology brought us drug eluting stents, maybe better but certainly more costly. Since the 80ies, too, rapidly evolving technology, rapidly evolving knowledge and increasing treatment options made guidelines, summarising state-of-the-art knowledge of diagnosis and treatment indispensable. The wealth of information makes it impossible to stay updated as a 'lonely cardiologist', without the streamlining of that information by guidelines established by peer leaders. These guidelines will never be perfect, and will never be applicable for all patients. The true art of modern cardiology is feeling by experience and clinical acumen when it is appropriate to treat according to the guidelines and when not. However, as guidelines they intend to give the cardiologist guidance in the treatment of the majority of patients: major divergences suggest either poor guidelines or poor practice.

Treatment not according the guidelines may either "undertreat" or "overtreat" the patient according to the current state-of-the-art. Both are undesirable, as they risk to waste health and resources. In a plethora of more and more effective technology, wasting resources to ineffective diagnostic or treatment strategies is as detrimental as wasting health: resources used are not available anymore. Money spent in obsolete diagnostic tests can not be used in promising new technology.

In most countries, there are two major levels of cardiology services: those without facilities for coronary angiography (CAG), PCI and CABG and those with those facilities. As a PCI needs a CAG, a CAG without facilities for interventions may need to duplicate the intervention. Further, PCI may fail (rarely and unexpectedly), and need urgent surgery. In Belgium, there are four levels of available facilities in the care programmes: A hospitals (those without any special facilities), B1 hospitals (those with only facilities for CAG), B2 hospitals (those with all facilities, except for CABG) and B3 hospitals (those with all facilities). For most purposes, we compared A, B1 and B2-B3 hospitals.

We aim to assess cardiac care programme variability in length of stay, use of diagnostic tests, therapeutic interventions and billed costs in a selected group of patients at low risk, i.e. patients less than 75 year old, discharged alive and characterised by the absence of diabetes or a previous cardiovascular disease admission. We compared the tests as observed with the recommendations of the guidelines. Further, we compared the prognosis of patients entering in the one or the other care programme, to assess if patients entering in a lower level hospital had a worse deal.

2. DEFINITION, INCIDENCE AND MANAGEMENT OF ACUTE MYOCARDIAL INFARCTION

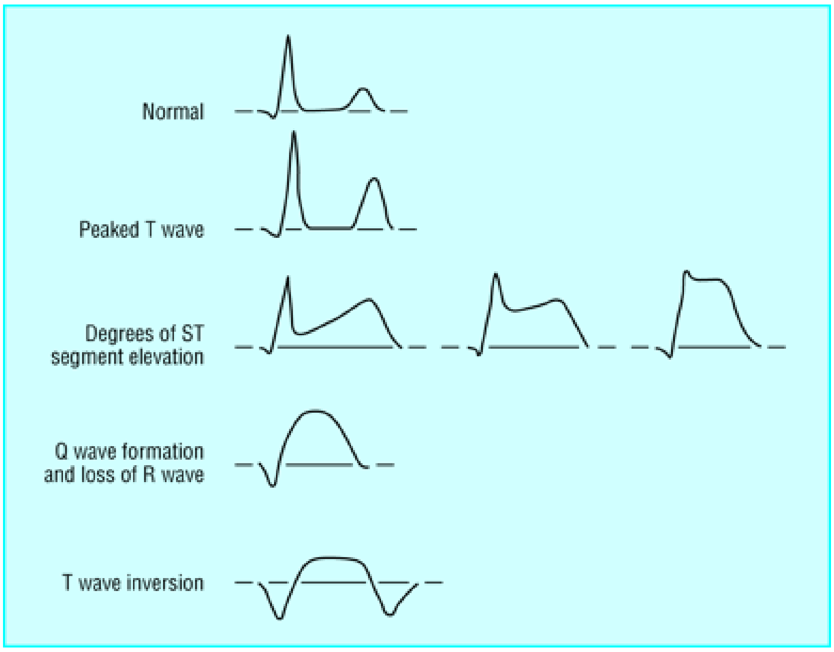
2.1. DEFINITION

A myocardial infarction (MI) is a condition in which myocardial tissue is lost due to prolonged ischemia. The World Health Organization's classic definition of acute myocardial infarction (AMI) requires that at least two of the following three criteria are met: a history of typical symptoms of ischaemic chest discomfort; evolutionary electrocardiographic tracings involving the development of Q-waves and an increase in the creatinine - kinase level greater than twice the upper reference limit. While this definition is clear-cut, many patients who show myocardial necrosis will not be included by using it. Recent developments in the detection of small quantities of myocardial necrosis using serum cardiac troponin levels have prompted a new definition of myocardial infarction.[5]

According tot the Joint European Society of Cardiology (ESC) / American College of Cardiology (ACC) Committee [6] any amount of myocardial necrosis caused by ischemia should be labeled as an infarction. The introduction of new biochemical techniques gave rise to the ability to detect small amounts of myocardial necrosis weighing less then 1.0 gram[6] and led to a paradigm shift in which MI was looked as being part of a broad spectrum of acute ischemic heart diseases denoted as Acute Coronary Syndromes (ACS). These extend from AMI, through minimal myocardial injury to unstable angina (UA), the latter referring to a syndrome of cardiac ischemia in which no myocardial necrosis could be documented. Pathophysiologically, a STEMI results from transmural ischemia of part of the myocardium due to a complete thrombotic occlusion of a coronary artery. In NSTEMI, it is assumed that a thrombus only partly blocks the vessel, yet allowing some antegrade blood flow through it. However small fragments of this thrombus can be teared off and spread to the distal microcirculation where ischemia and necrosis can be induced.

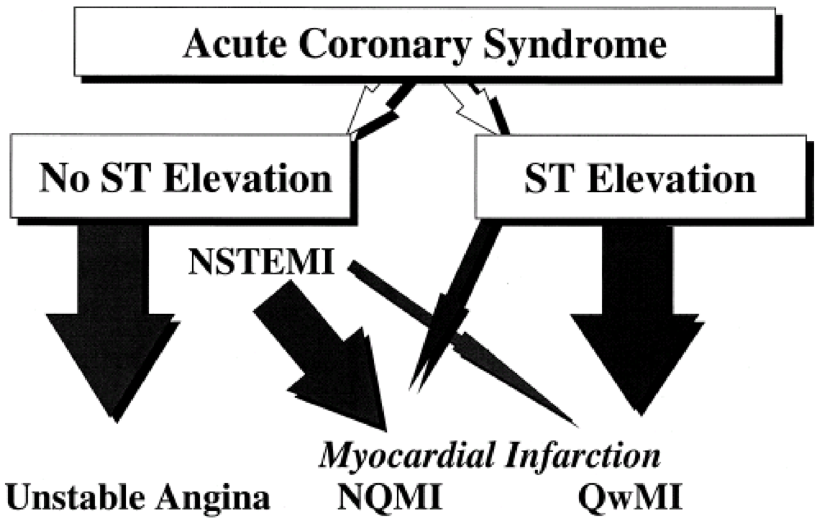
Patients presenting with acute chest pain, in which the attending physician suspects cardiac ischemia are considered as suffering an ACS. If the electrocardiogram (ECG) shows a typical ST-segment elevation, the patient is classified as having a STE-ACS (ST-segment elevation acute coronary syndrome) and from then on a specific emergency treatment pathway is established in which the decision whether or not to proceed to immediate reperfusion therapy is of utmost importance. Later on, most of these patients show biomarkers of myocardial necrosis (and hence can be fully classified as STEMI) and in some of them the ECG will show the development of Q-waves. These were mandatory in the older WHO definition.

Figure 1: Sequence of electrocardiographic changes seen during evolution of a STEMI.[7]



Some patients with an ACS do not show the typical ST-segment elevation on their admission ECG but present with other specific ST-segment changes or sometimes even a normal ECG. They can have different ECG-patterns which have different prognostic meanings: ST-depression, flat T-waves, T-wave inversion. When these patients eventually develop biochemical signs of myocardial necrosis, they are classified as having a NSTEMI (Non-ST-segment elevation myocardial infarction).

ACS were schematically represented by the Joint ESC/ACC Committee[6] as follows:



Infarctions in which no Q-waves developed following the acute event used to be classified as non-Q wave, nontransmural or subendocardial infarctions. These are included in the ICD-9 coding system (code 410.7). STEMI's more often lead to Q-wave MI whereas NSTEMI rather seldom give origin to Q-waves on the ECG. In the Euro Heart Survey[8], of

4431 STEMI's 64.8% lead to a final diagnosis of Q-wave MI, 22.2% to non Q-wave MI and 13.0% to the diagnosis of unstable angina. Of 5367 NSTEMI's, these figures respectively were 7.9%, 26.9% and 65.1%.

The ECG has a pivotal role in the management of patients with ACS. If the ECG shows an ST-segment elevation, these patients are from the start considered as having a STEMI although strictly speaking, the diagnosis of MI can only be made for certain when repetitive enzyme markers are indicative if myocardial necrosis. If the clinical picture is suggestive for MI but the ECG does not show the typical ST-segment elevations, the patient is classified as a NSTE-ACS which eventually – if biomarkers are positive - can turn out to be an infarction.

According to the definition proposed by the joint ESC/ACC consensus document, one should use the term "ACS with or without ST-elevation" as initial diagnoses on admission whereas Q-wave MI, non Q-wave MI and unstable angina as diagnoses at discharge.

It must be clear from the aforementioned considerations that patients with a STEMI are a distinct component of the ACS spectrum for which treatment aims to restore perfusion using fibrinolysis or primary percutaneous coronary intervention. However, NSTEMI and unstable angina are more heterogeneous in their presentation and may be poorly characterized in clinical practice, leading to greater variation in diagnosis and treatment. Unstable angina in particular has a wide range of clinical manifestations, resulting in a variable prognosis. This variation may be explained by the use of different definitions for unstable angina and NSTEMI, by differences in the characteristics of presenting patients, and by geographical practice variation, which can itself be influenced by factors such as the incidence of coronary heart disease in the local population, the type of resources available, and the physicians' perceptions of existing therapies.

The discrimination between STEMI and NSTEMI has important prognostic implications. Mortality in hospital is greater for patients who have a Q-wave MI, whereas rates of reinfarction, recurrent ischaemia, and long term mortality appear to be higher following non Q-wave MI. A large observational study in 1975-97 showed that mortality in hospital for patients with a diagnosis of Q-wave MI has declined from 24% to 14%, but mortality in hospital for non Q-wave MI has remained the same at 12%. Corresponding five year survival rates after Q-wave and non Q-wave MI were 75% and 65%, respectively.[9] According to some authors, the mortality of STEMI and NSTEMI is similar at 3-5 years.[10] Thus, it seems that the initially lower risk of NSTEMI vis-à-vis STEMI is lost in the following years.

In guidelines on ACS, early risk stratification of patients with NSTE-ACS has always been a big issue. One of the criteria used is the presence or absence of cardiac biomarkers. According to the ACC/AHA-2000 guidelines, cardiac troponins should be repetitively negative to allow a patient being classified as low risk. Patients in whom troponins are slightly elevated (troponin I > 0.01 but > 0.1 ng/ml) are considered as intermediate risk and tropinin values of > 0.1 ng/ml are indicative of high risk. As already mentioned earlier, any amount of myocardial necrosis caused by ischemia should be labeled as an infarction. If one agrees with that, any non ST-elevation ACS (NSTE-ACS) with the slightest troponin rise should be considered as a NSTEMI and hence any NSTEMI is to be considered as an intermediate or high risk ACS.

Some authors restrict the use of the term MI to cases in which a "substantial" amount of myocardial tissue has been lost and speak of "minimal cardiac injury" in those case that did not have sustained ST-elevation or the evolution of Q-waves and in which cardiac enzyme release is no more than twice the upper limit of normal.[11]

To complicate things even more, differentiating between UA and NSTEMI can become impossible when patients, admitted with an ACS without an enzyme-rise, undergoing early PCI, develop biomarkers solely due to the intervention as such. Strictly speaking, these patients have UA but they are re-categorized to NSTEMI because an enzyme rise has been introduced by the therapeutic intervention.

Cardiac troponins are very specific for cardiac necrosis which does not mean however that every documented cardiac necrosis is ischemic in origin. A cardiac troponin rise is considered as being the result of an AMI if it results from primary ischemic injury to the heart. Secondary ischemic damage or non-ischemic damage can occur in a variety of consitions such as pulmonary oedema, pulmonary embolism, renal failure, ….

2.2. INCIDENCE

As already mentioned, whereas patients with a STEMI are a discrete component of the ACS spectrum, non-STEMI and unstable angina are more heterogeneous in their presentation leading to a greater variation in diagnosis.

By changing definitions of MI and the introduction of the newer specific and sensitive biomarkers and introducing emergency interventions, uncertainty has been introduced in the diagnosis of MI. The ICD-9 code 410 differentiates MI's only in location and in being transmural or not, the latter more or less corresponding to Q-wave and non Q-wave infarctions respectively. ICD-9 code 411 implies "other acute and subacute forms of ischemic heart disease" which some physicians could use in cases where no cardiac injury at all is documented, whilst others could "tolerate" a minimal injury and still consider a patient as having unstable angina.

The incidence of non Q-wave MI seems to increase, possibly related to changes in management over time such as risk factor modification, reduction of prehospital delay and improvement in access to and advances in medical care. [12]In its 1996 guidelines, the ESC mentions that the incidence of non Q-wave MI (to be compared with NSTEMI) is from 20 to 40% of all infarctions but accepts that this figure may be increasing relating to the use of reperfusion therapy and/or more sensitive techniques of enzyme detection. Although one should be cautious in comparing different studies, this is illustrated by the following table with data from European registries that were published in recent years.

	STEMI	NSTEMI	U-ANGINA	TOTAL	PERIOD
GRACE (1)	32 %	27 %	41 %	10709	1999-2000
GRACE-UK[13] 2005	28 %	28 %	44 %	1371	1999-2002
GRACE (2)	9833 (34.1%)	9007 (31.2%)	9985 (34.6%)	28825	1999-2003
EHS (discharge diagnosis)	3438 (32.8%)	2648 (25.3%)	4398 (41.9%)	10484	2000-2001
EHS (admission)	42.3%	51.2%			

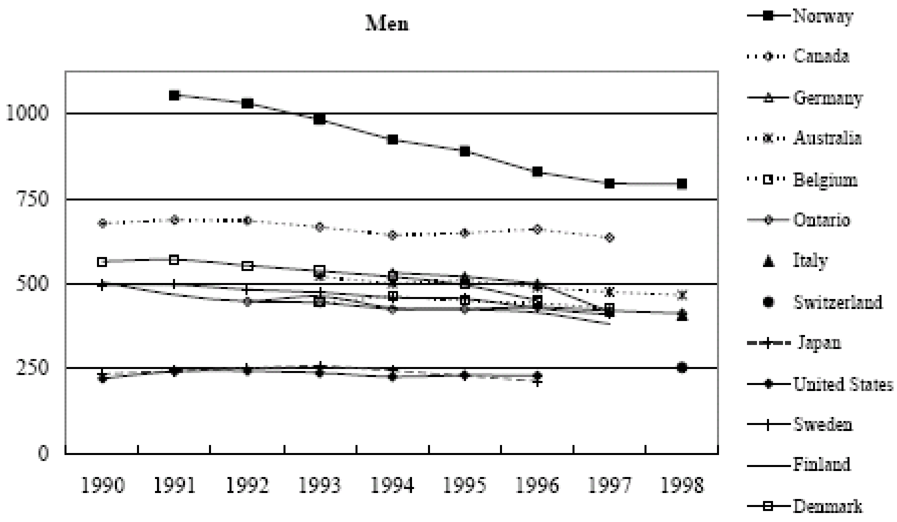
Because the underlying physiopathological problem is different, some demographic and clinical differences do exist between patients with STEMI and NSTEMI. The table, which is from the EHS for example, shows that NSTEMI patients tend to be older, contain relatively more females and have substantially more antecedent cardiovascular events.

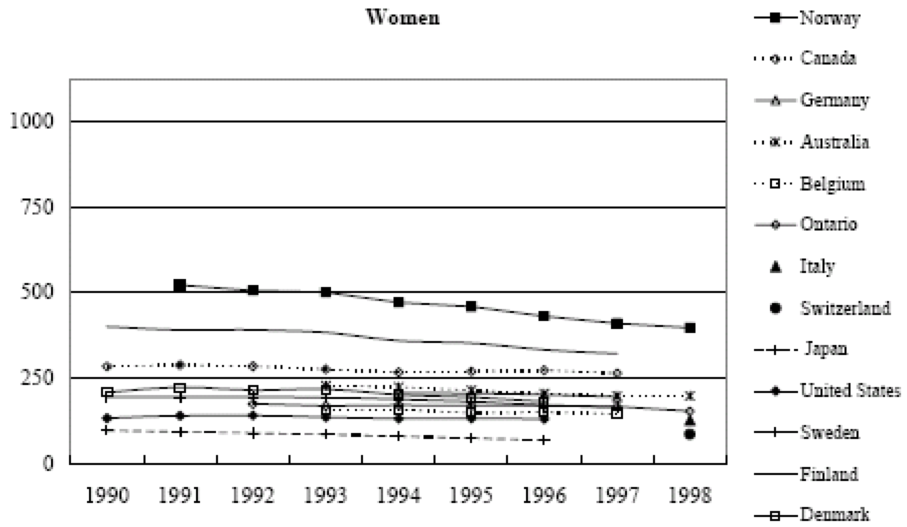
Table 1 Baseline demographic and clinical characteristics of the survey cohort categorized based on the initial electrocardiographic pattern

	ST elevation	No ST elevation	Undetermined
Age (years)	63·4 ± 13·0	65·8 ± 12·0	72·0 ± 10·3
Male gender (%)	71·6	64·4	65·5
Weight (kg)	77·9 ± 13·7	78·0 ± 14·3	77·0 ± 13·2
Height (cm)	169·9 ± 8·6	168·8 ± 9·0	168·3 ± 8·8
Prior MI (%)	22·3	35·6	45·3
Prior angina (%)	56·4	74·8	72·2
Prior HF (%)	8·2	11·9	28·0
Valve disease (%)	3·4	5·2	10·8
Pacemaker (%)	0·6	1·8	11·8
Prior CABG (%)	3·4	11·0	13·1
Prior PCI (%)	7·3	15·2	14·2
Diabetes mellitus (%)	21·1	23·5	31·7
Smoking — ever (%)	63·1	53·8	52·6
Hypertension (%)	51·6	63·6	64·0
Hyperlipidaemia (%)	46·8	54·6	46·7
Family history (%)	27·4	29·3	23·1
Cancer — ever (%)	4·9	5·8	7·8
Prior CVA/TIA (%)	5·9	8·1	13·9
Renal failure (%)	3·4	5·8	11·2
COPD (%)	8·5	8·7	13·1
PVD (%)	7·0	10·6	18·0
Prior GI bleed (%)	4·9	4·0	6·1

Continuous variables are presented as mean ± SD. MI=myocardial infarction; HF=heart failure; CABG=coronary artery bypass grafting surgery; PCI=percutaneous coronary intervention; CVA=cerebrovascular accident; TIA=transient ischaemic attack; COPD=chronic obstructive pulmonary disease; PVD=peripheral vascular disease; GI=gastrointestinal.

The following chart shows the overall age-standardised admission rates for AMI in different OECD countries (admissions per 100 000 population aged 40 and over).





This figure shows that in the male population studied, about 450 admissions for AMI occur each year in Belgium. For most countries the number of admissions for AMI has remained relatively level during the 1990s, using raw data or data age-standardised to the European population aged 40 and over.

Interpreting cross-country comparison is difficult since both event-based and patient-based admissions are included and the magnitude of the difference between the two is not known. For example, admission rates for AMI in Ontario appear to be lower than Belgium, despite a much higher burden of AMI in Canada than Belgium. The data for Ontario are based on patient-based data whereas the data for Belgium are not, meaning that the figures shown for Belgium are likely higher than the true admission rates due to double counting of patients admitted at least twice within the same year for AMI.

2.3. MANAGEMENT OF ACUTE MYOCARDIAL INFARCTION

2.3.1. General Guidelines

Guidelines on the treatment of AMI have been issued since 1990, first jointly by the American College of Cardiology (ACC) and the American Heart Association (AHA) and later by the European Society of Cardiology (ESC) as well. Initially these guidelines referred to AMI in general but from 2000 on, both the ESC and ACC/AHA issued separate guidelines on NSTEMI which were updated in 2002. Guidelines on STEMI were updated by the ESC in 2003 and by ACC/AHA in 2004 (cf. table).

1996	ESC	ACUTE MI
1996	ACC/AHA	ACUTE MI
1999	ACC/AHA	ACUTE MI UPDATE 1996
2000	ESC	ACS: NSTEMI
2000	ACC/AHA	UNSTABLE ANGINA and NSTEMI: SUPERSEDE 1994 GUIDELINES
2002	ESC	ACS: NSTEMI UPDATE 2000
2002	ACC/AHA	UNSTABLE ANGINA and NSTEMI UPDATE
2003	ESC	STEMI UPDATE 1996
2004	ACC/AHA	STEMI REVISION 1999

Because we are considering treatment of AMI during the years 1999-2001, we refer mainly to the guidelines which were in use during that period and if applicable we consider later adjustments and refinements. The following table shows the ESC guidelines (with levels of evidence) which were in use during our study period. Later amendments and corresponding guidelines from the ACC/AHA are shown in an Appendix A.

	1996 GUIDELINES AMI ESC		LEVEL
INITIAL	Aspirin (ASA)	except contra-indicated	I
	Thrombolysis (TL)	for STEMI or LBBB presenting < 12 h of onset of symptoms	I
		not for NSTEMI	I
	Heparin	heparin if in combination with tPA	I
	Early beta-blocker (BB)	tachycardia, hypertension, pain	I
		all patients iv beta-blocker, unless contra-indicated	2
	Early ACE-inhibitor	all patients	3
	Primary PCI	STEMI: on site available: therapeutic option only when rapid access (1h) to cath lab possible	I
		STEMI: not on site: reserved for those in whom the benefits of reperfusion are great and risk of thrombolysis high	2
		STEMI: rescue PCI in case of failed thrombolysis	2
		NSTEMI: no early invasive strategy	2
	CABG	very seldom indicated	I
SUB-SEQUENT	CAG	in case of new angina in post-infarction phase	I
	PTCA	no routine PTCA following thrombolysis	I
		in case of angina or recurrent ischemia following thrombolysis	I
		in NSTEMI and residual ischemia	3
	CABG	uncontrolled symptoms, left main lesion or three-vessel-disease with poor LV function	I
DIS-CHARGE	Aspirin	all patients (target > 85%)	I
	BB	in patients at moderate risk without contra-indications (target > 35%)	I
	ACE-inhibitor	in pts who experienced HF in the acute episode or with EF<40% (target > 20%)	I
	Lipid lowering drugs	if total cholesterol > 212 mg%	2

The care of patients with AMI can be divided into four phases:

- Emergency care when the main considerations are to make a rapid diagnosis and early risk stratification, to relieve pain and to prevent or treat cardiac arrest.
- Early care in which the chief considerations are to initiate therapy to limit infarct size and to prevent infarct extension and expansion and to treat immediate complications such as pump failure, shock and life-threatening arrhythmias.
- Subsequent care in which the subsequent complications are addressed.
- Risk assessment and measures to prevent progression of coronary artery disease, relapse, heart failure and death.

In this report, we will primarily address topics related to early and subsequent care (# 2 and 3) because the available administrative data mostly relate to this part of patient care. We will discuss STEMI and NSTEMI treatment separately.

2.3.2. STEMI

For patients with the clinical presentation of MI and with persistent ST-segment elevation, early reperfusion should be performed unless clear contraindications are present. Because of a worse prognosis and proven benefit of thrombolytic therapy, patients with left bundlebranch block (LBBB) on their index ECG are considered and treated as STEMI's. Reperfusion can be achieved chemically by means of thrombolytic therapy (TL) or mechanically by means op percutaneous coronary intervention (P-PCI).

Medical, Non-Thrombolytic, Therapy

Relief of pain is of paramount importance, not only for humane reasons but because the pain is associated with sympathetic activation which causes vasoconstriction and increases the workload of the heart. Intravenous opioids are the analgesics most commonly used. Aspirin forms part of the early management of all patients with suspected STEMI and should be given promptly, and certainly within the first 24 hours. Oxygen should be administered especially to those who are breathless or who have any features of heart failure or shock.

In the setting of ACS, beta-blockers (BB) are used both for acute therapeutic and secondary preventive purposes. In STEMI, they have shown to relieve pain and to lower acute mortality, especially from ventricular fibrillation and cardiac rupture. The ISIS-1-trial[14] was a landmark study of the intravenous use of BB in the acute phase of MI in which 16000 patients were studied. Those randomized to intravenous atenolol had a 15% reduction in mortality at 7 days. Pooling of 28 trials of intravenous BB[15] conducted prior to the thrombolytic era revealed an absolute reduction of mortality at 7 days from 4.3% to 3.7% or six lives saved per 1000 treated. Two randomized trials of intravenous beta-blockade were undertaken since the widespread use of fibrinolysis. The number of events was too small to allow conclusions to be drawn. A post-hoc analysis of the use of atenolol in the GUSTO-I trial and a systematic review did not support the routine early intravenous use of beta-blockers. In its 2003 update on management of patients with STEMI, the ESC concludes that there is a good case for the greater use of an intravenous beta-blocker when there is tachycardia (in the absence of heart failure), relative hypertension or pain unresponsive to opioids. It was thought that in most patients, oral beta-blockade would suffice.

Thrombolysis

The term thrombolysis refers to the dissolution of a thrombus which completely blocks a coronary artery in a STEMI patient. Fibrinolytics are chemicals that interfere with fibrin, a major component of thrombus. Thrombolytic therapy or thrombolysis indicates the use of infusions of fibrinolytic agents to destroy or dissolve thrombi in blood vessels. The terms thrombolysis and fibrinolysis are used exchangable.

More than 150 000 patients have been randomized in trials of thrombolysis vs control, or one fibrinolytic regimen compared with another. For patients within 12 h of the onset of symptoms of infarction, the overall evidence for the benefit of fibrinolytic treatment is overwhelming. According to the Fibrinolytic Therapy Trialists' analysis for those presenting within 6 hours of symptom onset, approximately 30 deaths are prevented per 1000 patients treated (NNT = 33), with 20 deaths prevented per 1000 patients treated for those between 7 and 12 h (NNT = 50).[16] The ISIS-2 study demonstrated an important additional benefit of aspirin so that there was a combined reduction of approximately 50 lives per 1000 patients treated.[17] It is not clear whether aspirin works by enhancing fibrinolysis, preventing reocclusion or by limiting the microvascular effects of platelet activation. In studies on late reocclusion, aspirin was more effective in preventing recurrent clinical events than in maintaining patency.

Thrombolytics should be administrated with the minimum of delay. A realistic aim is to initiate fibrinolysis within 90 min of the patient calling for medical treatment ("call to needle" time) or within 30 min of arrival at the hospital ("door to needle" time). Fibrinolytic therapy should not be given to patients in whom infarction has been established for more than 12 h, unless there is evidence of ongoing ischaemia, with the ECG criteria for fibrinolysis. In patients over 75 years old, the benefit of thrombolysis is less clear because of an increased risk of serious bleeding but overall, thombolysis may still be beneficial. The ESC-2003 guidelines propose elderly patients without contraindications to be given fibrinolytic therapy when timely mechanical reperfusion can not be performed.

Cerebral bleeding is the most dreaded complication of thrombolytic therapy. There is an excess of approximately two non-fatal strokes per 1000 surviving patients treated. Of these, half are moderately or severely disabling. Advanced age, lower weight, female gender, prior cerebrovascular disease and systolic or diastolic hypertension on admission are significant predictors of intracranial haemorrhage.

Absolute and relative contraindications to thrombolytic therapy are displayed in the table.[18]

Table 1 Contraindications to fibrinolytic therapy
Absolute contraindications
Haemorrhagic stroke or stroke of unknown origin at any time
Ischaemic stroke in preceding 6 months
Central nervous system damage or neoplasms
Recent major trauma/surgery/head injury (within preceding 3 weeks)
Gastro-intestinal bleeding within the last month
Known bleeding disorder
Aortic dissection
Relative contraindications
Transient ischaemic attack in preceding 6 months
Oral anticoagulant therapy
Pregnancy or within 1 week post partum
Non-compressible punctures
Traumatic resuscitation
Refractory hypertension (systolic blood pressure >180 mm Hg)
Advanced liver disease
Infective endocarditis
Active peptic ulcer

Heparin has been extensively used during and after fibrinolysis, especially with tissue plasminogen activator. Heparin does not improve immediate clot lysis but coronary patency evaluated in the hours or days following thrombolytic therapy with tissue plasminogen activator appears to be better with intravenous heparin. No difference in patency was apparent in patients treated with either subcutaneous or intravenous heparin and streptokinase.

Primary PCI

Primary percutaneous coronary intervention (P-PCI) is defined as angioplasty and/or stenting without prior or concomitant fibrinolytic therapy and is the preferred therapeutic option when it can be performed within 90 min after the first medical contact ("call to balloon time"). It requires an experienced team, which includes not only interventional cardiologists, but also skilled supporting staff. This means that only hospitals with an established interventional cardiology programme should use primary PCI as a routine treatment option for patients presenting with the symptoms and signs of acute myocardial infarction. Lower mortality rates among patients undergoing primary PCI are observed in centres with a high volume of PCI procedures. For patients admitted to a hospital without catheterization facilities on site, it is not clear whether routine transportation to the nearest interventional catheterization laboratory is needed. The DANAMI-2 investigators have investigated whether a strategy of routine transfer to a tertiary care hospital for primary PCI is superior to in-hospital thrombolysis.[19] A significant reduction in the combined end-point of death, reinfarction and stroke was found after 30 days in the transferred patients undergoing primary PCI (14.2% to 8.5%), while mortality reduction was not significant (8.6% vs 6.5%). In the CAPTIM study comparing pre-hospital (ambulance) fibrinolysis with primary PCI, no significant difference was found for this combined end-point (8.2% vs 6.2%) and 30-day mortality was 1% higher in the primary PCI arm (3.8% vs 4.8%).[20] Recent findings from the GRACE registry[21] support the strategy of directing patients with suspected ACS to the nearest hospital with acute care facilities, irrespective of the availability of a catheterisation laboratory and argue against early routine transfer of these patients to tertiary care hospitals with interventional facilities.

Patients with contra-indications to fibrinolytic therapy have a higher morbidity and mortality than those eligible for this therapy. Primary PCI can be performed with success in a large majority of these patients. According tot the ESC 2003 guidelines, P-PCI is the preferred treatment for patients in shock.

In 2005, the ESC published guidelines[22] on the use of PCI, in which it is stated that the superiority of P-PCI over thrombolytic therapy seems to be especially clinically relevant for the time interval between 3 and 12 h after onset of chest pain. Within the first 3 h after onset of chest pain both reperfusion strategies seem equally effective in reducing infarct size and mortality. Therefore, thrombolysis is still considered by the expert panel as a viable alternative to P-PCI, if it can be delivered within 3 hours after onset of chest pain.

Acute Revascularization Following Thrombolysis

PCI performed as a matter of policy immediately after fibrinolytic therapy ("facilitated PCI"), in order to enhance reperfusion or reduce the risk of reocclusion, has proved disappointing in a number of earlier trials, all showing a tendency to an increased risk of complications and death. Increased experience and the availability of stents and more potent antiplatelet agents (glycoprotein IIb/IIIa receptor antagonists and thienopyridines) have made PCI following fibrinolysis effective and safe. A combined pre-hospital pharmacological and mechanical reperfusion strategy might prove to be beneficial and still is under investigation.

Rescue PCI is defined as PCI performed on a coronary artery which remains occluded despite fibrinolytic therapy. Limited experience suggests a trend towards clinical benefit if the infarct-related vessel can be recanalized at angioplasty. Although angioplasty success rates are high, an unsolved problem is the lack of reliable non-invasive methods for assessing patency of the infarct-related coronary artery.

Delayed Revascularization Following Thrombolysis

Following the "early care" episode, AMI patients have to be assessed clinically and by additional non invasive techniques if indicated to define those which would benefit from coronary angiography (CAG) and possibly revascularisation. The 1996 ESC guidelines mention that the routine use of CAG and elective PTCA following thrombolytic therapy does not improve left ventricular function or survival. Although analyses from several trials identified a patent infarct-related vessel as a marker for good long-term outcome, it has not been shown that late PTCA with the sole aim of restoring patency influences late events.[10] According to these guidelines, mild post-infarction angina in patients with a previous history of angina may respond satisfactorily to the usual medical treatment, but new angina and especially angina at rest in the early post-infarction phase requires further investigation and treatment, if possible with PTCA. CABG may be indicated if symptoms are not controlled by other means or if CAG demonstrates lesions, such as left main stenosis or three vessel disease with poor left ventricular function, for which surgery improves prognosis.

In the 1996 ACC/AHA guidelines[23] and their 1999 update[24] confirm that there is no place for routine CAG and PTCA after successful thrombolytic therapy to find persistently occluded infarct-related arteries in an attempt to revascularize the artery or to identify patients with three-vessel disease.

Risk stratification following the early care episode can eventually lead to the decision to perform a CAG and depending on its results, the decision to revascularize has to be taken. Clinical indicators of high risk in the acute phase include hypotension, persistent heart failure, malignant arrhythmias, and persistent chest pain or early angina on minimal exertion. This initial clinical stratification is considered important because the yield of investigations depends critically on the pre-test probability of a positive result. Especially exercise-ECG to evaluate residual ischemia and echocardiography (in intermediate risk patients) to assess left ventricular function are to be used to decide whether to proceed to CAG. Patients with high-risk clinical markers tend to be older, to have multiple risk factors, and to have had previous infarction, and they are candidates for early CAG. If angiography reveals coronary anatomy that is suitable for intervention and if there is evidence of viable myocardium that is jeopardized, then revascularization is appropriate.

The 2003 ESC guidelines extend the use of CAG following AMI to patients at high risk by imaging criteria, which are those with left ventricular ejection fraction <35% or those with extensive or profound inducible ischaemia. In these patients, angiography is considered appropriate and they should be managed in the same way as those who are at high risk by clinical criteria alone. Patients at low risk by imaging criteria are those with an ejection fraction >50% or those with limited or mild inducible ischaemia (affecting less than 20% of the remaining viable myocardium), particularly if the ischemia is in the infarct zone rather than remote. These patients can be managed medically unless intervention is required for symptom relief.

In patients that underwent a successful P-PCI early risk assessment is less important since it can be assumed that the infarct-related coronary lesion has been treated and stabilized and the main concern is to detect inducible ischaemia in other territories. Outpatient stress testing at 6 weeks using the ECG or imaging techniques would be appropriate in these patients.

2.3.3. NSTEMI

Patients with an ACS, without persistent ST-segment elevation on their ECG should receive baseline treatment including, aspirin, low-molecular-weight heparin, beta-blockers (if not contra-indicated) and nitrates. In the 2000 guidelines, infusion of GPIIb/IIIa receptor inhibitor has been added on top of baseline treatment for high risk individuals being considered for PCI. Later (2002) clopidogrel has been added as an extra antiplatelet agent.

Acute Medical Treatment

In the year 2000, both the ESC and the ACC/AHA published guidelines specifically aimed at unstable angina and NSTEMI. Evidence for the beneficial effects of beta-blockers in UA is based on limited randomized trial data, along with pathophysiological considerations and extrapolation from experience in stable angina and acute STEMI. They are recommended in ACS in the absence of contraindications.

The use of nitrates in unstable angina is largely based on pathophysiological considerations and clinical experience. The major therapeutic benefit is probably related to the venodilator effects that lead to a decrease in myocardial preload and left ventricular end-diastolic volume resulting in a decrease in myocardial oxygen consumption.

Calcium channel blockers provide symptom relief in patients already receiving nitrates and beta-blockers; they are useful in some patients with contraindications to beta blockade. Nifedipine, or other dihydropyridines, should not be used without concomitant beta-blocker therapy. Calcium channel blockers should be avoided in patients with significantly impaired left ventricular function or atrioventricular conduction.

Intracoronary thrombosis plays a major role in acute coronary syndromes. Thrombus consists of fibrin and platelets. Hence, in order to discuss medical strategies in ACS, one has to consider different drug regimens which interfere with thrombus formation and thrombus resolution: drugs which inhibit thrombin (unfractionated heparin or low-molecular-weight heparin), antiplatelet agents (aspirin, thienopyridins, glycoprotein IIb/IIIa receptor blockers) and fibrinolytic agents.

Acute treatment with aspirin is recommended in all patients with suspected ACS in the absence of contraindications.

The evidence for the use of unfractionated heparin in NSTE-ACS is less robust than for other treatment strategies. Nevertheless, clinical guidelines recommend a strategy including administration of unfractionated heparin with aspirin as a pragmatic extrapolation of the available evidence. As far as low-molecular-weight heparins (LMWH) are concerned, there is evidence in aspirin treated patients that enoxaparin is better than placebo.[25]

In the year 2000 guidelines, glycoprotein IIb/IIIa receptor blockers (GP IIbIIIa) were advocated for patients judged to be at high risk and to be administrated while waiting and preparing for angiography. In the larger placebo-controlled trials of GPIIb/IIIa receptor blockers in patients with ACS, the treatment benefit was particularly apparent in those patients who underwent early coronary revascularization. A meta-analysis from Boersma showed a strong treatment effect (death and MI) in patients undergoing PCI but no effect in those not undergoing intervention.[26]

Fibrinolytic treatment has been shown to decrease the amount of intracoronary thrombus and to significantly improve survival in patients with STEMI. In contrast, in several studies with different thrombolytics, a deleterious effect has consistently been observed in patients with UA. The risk of death and MI in a pooled series of 2859 patients was 9 8% in the fibrinolytic group and 6 9% in the control group. The Fibrinolytic Therapy Trialists' overview showed that in 3563 patients with suspected MI and ST-segment depression, the mortality was 15 2% vs 13 8% for control patients. Therefore, thrombolytic therapy is not recommended for patients with NSTE-ACS.[16]

Invasive Assessment and Treatment

From the year 2000 on, both the European and the American guidelines elaborate extensively on risk assessment in patients with NSTE-ACS and the related use of two different strategies depending on it: an early conservative and an early invasive strategy.

In the early conservative strategy, CAG is reserved for patients with evidence of recurrent ischemia (angina or ST-segment changes at rest or with minimal activity) or a strongly positive stress test despite vigorous medical therapy.

In patients judged to be at high risk for progression to myocardial infarction or death an early invasive strategy is recommended. These are patients,

(a) with recurrent ischaemia (either recurrent chest pain or dynamic ST-segment)

(b) with early post-infarction unstable angina

(c) with elevated troponin levels

(d) who develop haemodynamic instability within the observation period

(e) with major arrhythmias (repetitive ventricular tachycardia, ventricular fibrillation)

(f) with diabetes mellitus

(g) with an ECG pattern which precludes assessment of ST-segment changes

Because "elevated troponin level" is one of the criteria to define high-risk patients and as discussed earlier, a rise in cardiac biomarkers indicates infarction, at least according to this strict guidelines interpretation, we have to consider all patients with NSTEMI to the high-risk NSTE-ACS.

As a rule of thumb, CAG is indicated in these patients because they are likely to benefit from revascularization in terms of both symptom improvement and long-term survival. However, the decision to proceed to diagnostic angiography and eventually to revascularization is influenced not only by clinical risk status or the coronary anatomy, but also by a number of additional factors, including anticipated life expectancy, ventricular function, comorbidity, functional capacity, severity of symptoms, and quantity of viable myocardium at risk. For example, patients with distal obstructive coronary lesions or those who have large quantities of irreversibly damaged myocardium, are unlikely to benefit from revascularization, particularly if they can be stabilized on medical therapy.

In most cases, "early" CAG is performed within the first 48 hours or at least within hospitalization period. In patients with lesions suitable for myocardial revascularization, the decision regarding the most suitable procedure is made after careful evaluation of the extent and characteristics of the lesions in consultation with surgical colleagues. In general, recommendations for the choice of a revascularization procedure in unstable angina are similar to those for elective revascularization procedures. If angiography shows no options for revascularization, owing to the extent of the lesions and/or poor distal run-off, or reveals no major coronary stenosis, patients will be referred for medical therapy.

In the 2002 ACC/AHA guidelines[27] on NSTEMI, the following flowchart is proposed:

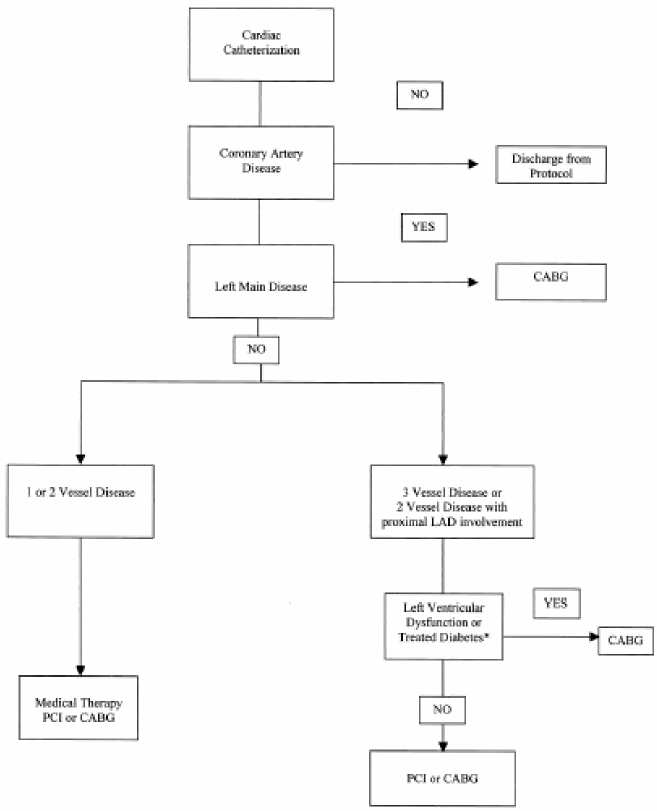


Figure 12. Revascularization strategy in UA/NSTEMI. *There is conflicting information about these patients. Most consider CABG to be preferable to PCI.

From the same reference, recommendations for revascularization with PCI and CABG in patients with NSTE-ACS is depicted in the following table:

Table 20. Mode of Coronary Revascularization for UA/NSTEMI

Extent of Disease	Treatment	Class/Level of Evidence
Left main disease,* candidate for CABG	CABG PCI	I/A III/C
Left main disease, not candidate for CABG	PCI	IIb/C
Three-vessel disease with EF <0.50	CABG	I/A
Multivessel disease including proximal LAD with EF <0.50 or treated diabetes	CABG or PCI	I/A IIb/B
Multivessel disease with EF >0.50 and without diabetes	PCI	I/A
One- or 2-vessel disease without proximal LAD but with large areas of myocardial ischemia or high-risk criteria on noninvasive testing (see Table 17)	CABG or PCI	I/B
One-vessel disease with proximal LAD	CABG or PCI	IIa/B†
One- or 2-vessel disease without proximal LAD with small area of ischemia or no ischemia on noninvasive testing	CABG or PCI	III/C†
Insignificant coronary stenosis	CABG or PCI	III/C

*≥50% diameter stenosis.
†Class/level of evidence I/A if severe angina persists despite medical therapy.

From these guidelines, it is clear that it should be kept in mind that CAG is not mandatory being followed by PCI and that in patients with single or double vessel disease without proximal LAD involvement or with only a small area of ischemia, scientific evidence for revascularization is rather poor.

2.3.4. Non-Invasive Diagnostic Investigations

Patients with suspected MI are initially assessed and cared for in the emergency care department where repeat ECG and lab-tests are performed to make up diagnosis and to decide which therapeutic options have to be taken. Depending on the mode of therapy chosen, AMI-patients will then further be transferred tot the coronary care unit (CCU) or the catheterization laboratory.

Electrocardiographic monitoring for arrhythmias should be started immediately in any patient suspected of having sustained an AMI. This should be continued for at least 24 hours or until an alternative diagnosis has been made. Further ECG monitoring for arrhythmias is dependent upon the perceived risk to the patient and upon the equipment available. When a patient leaves the CCU, monitoring of rhythm may be continued, if necessary, by telemetry. More prolonged monitoring is appropriate for those who have sustained heart failure, shock or serious arrhythmias in the acute phase as the risk of further arrhythmias is high.

In both STEMI and NSTEMI, risk assessment following the acute episode is important to decide which further strategy is to be followed. Patients at highest risk are those with residual cardiac ischemia and with severely depressed left ventricular function. This can be assessed clinically and by means of imaging techniques and stress testing. The appropriateness of these exams as defined by in the 2003-ESC guidelines on STEMI, is depicted in the following table:

Table 6 Summary of indications for imaging and stress testing

	At presentation	Within 48 h	Before discharge	After discharge[a]
Rest echo	If required for diagnosis	For LV function and thrombus	For LV function, heart failure, shock or new murmur[b]	
Stress echo			For viability and ischaemia[c]	If not before discharge[c] or if primary PCI
Rest MPS	If required for diagnosis			
Stress MPS			For viability and ischaemia[c]	If not before discharge[c] or if primary PCI
Rest RNV			Alternative to echo for LV function	
Stress ECG			For ischaemia[c]	If not before discharge[c] or if primary PCI
CAG	If required for primary PCI	If clinical high risk	If imaging high risk, medium risk with symptoms, or intractable symptoms	

Echo = transthoracic echocardiography or transoesophageal if required, MPS = myocardial perfusion scintigraphy, RNV = radionuclide ventriculography, CAG = coronary arteriography, PCI = percutaneous coronary intervention

[a] = early risk assessment preferred

[b] = rest echo indicated at any stage for heart failure, shock or new murmur.

[c] = choice between techniques will depend upon local expertise but imaging technique preferable

In patients with NSTEMI, a predischarge stress test is useful to confirm the diagnosis of coronary artery disease in patients in whom such diagnosis has not yet been established and to predict the medium and long-term risk for subsequent coronary events. Exercise testing has a high negative predictive value. Parameters reflecting cardiac performance provide at least as much prognostic information as those reflecting ischaemia, while the combination of these parameters gives the best prognostic information. A significant proportion of patients cannot perform an exercise test and this in itself is associated with an adverse prognosis. Adding an imaging technique for the direct detection of ischaemia, such as perfusion scintigraphy or stress echocardiography, further increases the sensitivity and specificity for prognosis, especially in women, although large long-term prognostic studies with stress echocardiography in patients after an episode of unstable CAD are still lacking.

2.3.5. Long Term Management Following AMI

After the acute phase of a MI it is important to identify patients at high risk of further events such as reinfarction or death and hopefully to intervene in order to prevent these events. For secondary prevention both non-pharmacologic and pharmacologic measures are indicated. Patients should receive individualized advice on a healthy diet, weight control, smoking and exercising. Blood pressure controle should be optimized. The useful mnemonic “ABCDE” (Aspirin and antianginals; Beta-blockers and blood pressure; Cholesterol and cigarettes; Diet and diabetes; Education and exercise) has been proposed in guiding treatment.[28]

Antiplatelets

The Antiplatelet Trialists Collaboration meta-analysis demonstrated about a 25% reduction in reinfarction and death in post-infarction patients. In the trials analysed, aspirin dosages ranged from 75 to 325 mg daily.[29] There is some evidence that the lower dosages are effective with fewer side effects. In patients who do not tolerate aspirin, clopidogrel is a good alternative antiplatelet drug. Based on the results of the CURE-study, clopidogrel 75 mg should be prescribed for at least 9, possibly 12 months, in patients with NSTE-ACS.[30]

Beta-blockers

Several trials and meta-analyses have demonstrated that beta-blockers (BB) reduce mortality and reinfarction by 20-25% in those who have recovered from AMI. The 1996 ESC Guidelines on the management of acute MI[23] suggest a minimum target figure of BB prescription in 35% of patients. It was admitted that 25% of AMI-patients have contra-indications for BB because of uncontrolled heart failure or respiratory problems while of the remainder, half were defined as low risk in whom the benefit of BB was thought of as being low. At that time, opinion was divided as to whether BB should be prescribed to all those for whom they are not contra-indicated or whether they should only be given to those at moderate risk who have the most gain. A meta-analysis of 82 randomized trials, published in 1999[31] provided strong evidence for long-term use of beta-blockers to reduce morbidity and mortality after AMI even if fibrinolytic agents had been given or ACE inhibitors were co-administered. The significant mortality reductions observed with beta-blockers in heart failure in general, further support the use of these agents after MI. In its 2003 update on management of patients with STEMI, the ESC suggests that BB should be used indefinitely in all patients who recovered from an AMI and without contraindications.

Evidence for the beneficial effects of BB in UA is based on limited randomized trial data, along with pathophysiological considerations and extrapolation from experience in stable angina and AMI.[32] In the year 2000 recommendations of the Task Force Report of the ESC, BB are recommended in acute coronary syndrome in the absence of contraindications. The absolute contraindications for the use of BB are severe bradycardia, pre-existing high-grade AV block, sick sinus syndrome and severe, unstable heart failure (mild to moderate heart failure is actually an indication for BB). Asthma and bronchospasm are relative contraindications .[33] Conditions traditionally thought of as relative contraindications to the use of β-blockers have been addressed by the American Medical Association. They state that in patients with asthma, diabetes mellitus, chronic obstructive lung disease (COPD), severe peripheral vascular disease, PR interval >0.24 seconds, and moderate to severe left ventricular failure, benefits in post-MI patients often outweigh the risks.[28] In a 2001 update, the AHA and ACC in a joint guideline[34] contend that BB should be started in all post-MI and acute ischemic syndrome patients and that these should be continued indefinitely.

Despite many interventions that have been proved to reduce recurrence of myocardial infarction, audits of practice consistently reveal suboptimal control of cardiovascular risk factors and underuse of antiplatelet agents, BB and lipid lowering drugs in patients with coronary heart disease.[35] In a systematic review of randomised trials of secondary prevention in coronary heart disease, McAlister et al report on the impact of disease management programmes on the use of BB in some older studies. In a 1984 WHO-report[36], the use of BB in European men discharged after MI increased from 29 to 44% and in a UK study by Jones et al[37], BB use remained unchanged at 31%. Later on, the use of BB following MI increased in most countries studied.

Researchers from Yale University School of Medicine, Yale-New Haven Hospital Center for Outcomes Research and other institutions used data on 335,244 patients with AMI discharged from 682 hospitals from the National Registry of Myocardial Infarction and hospital characteristic data from the American Hospital Association Annual Survey of Hospitals. They examined associations between hospital characteristics and hospital-level rates of change in beta-blocker use during from 1996 to 1999. The overall rate of beta-blocker use varied over time from about 46 percent of patients in April 1996 to more than 68 percent of patients in September 1999. The range in hospital-level changes in beta-blocker rates was substantial, from a decline of 50 percentage points to an increase of 35.7 percentage points.[38]

GRACE data from July 1999 to December 2001 showed that BB use was already widely adopted in 1999 and did not change significantly over the subsequent 2.5 years.[39] In comparing contemporary management of ACS between UK and different European and non-European countries, GRACE investigators in a 2005 paper[13] observed a rather homogeneous use of BB on discharge, ranging from 70 to 78% of patients. In its 2005 version UpToDate[40] concludes that as many as 80 to 90 percent of patients with acute MI are eligible for BB therapy.

ACE- inhibitors and lipid-lowering drugs

Because at the time, ACE-inhibitors and lipid-lowering agents were subjected to specific reimbursement rules, we do not know exactly how many patients in our survey were treated with these agents. Hence we don not elaborate extensively on their use following AMI. In the 1996 ESC-guidelines, ACE-inhibitors on discharge were indicated in patients who experienced heart failure in the acute episode or who had a depressed left ventricular function (EF<40%). A minimum target figure at the time of discharge was suggested of > 20%. The 2003 ESC guidelines on STEMI state that there is a strong case for administering ACE inhibitors to patients who have experienced heart failure in the acute event, even if no features of this persist, who have an ejection fraction of less than

40%, or a wall motion index of 1.2 or less, provided there are no contraindications. A policy of continued administration of an ACE-inhibitor after myocardial infarction similar to and in combination with aspirin and a beta-blocker can be defended if tolerated well. Guidelines on the use of ACE-inhibitors in the secondary prevention following NSTEMI especially refer to patients with impaired left ventricular function.

Patients should be prescribed lipid-lowering therapy with statins if, in spite of dietary measures, total cholesterol levels of 190 mg and/or LDL-cholesterol levels of 115 mg still persist. The results from the HPS study, however, suggest that statin treatment should be extended to those with even lower lipid levels, including elderly patients. In patients with low HDL-cholesterol levels, a fibrate should be considered. Controversy exists as to how soon treatment should be started after the event. Data from a Swedish registry suggest that an early and aggressive treatment with lipid-lowering agents might be preferable.[18] In the Euro Heart Survey, the use of aspirin, beta-blockers, ACE-inhibitors, and heparins for patients with STE-ACS were 93 0%, 77 8%, 62 1%, and 86 8%, respectively, with corresponding rates of 88 5%, 76 6%, 55 8%, and 83 9% for NSTE-ACS patients.

2.3.6. Length of Stay

Most patients with an uncomplicated infarction, especially those in whom reperfusion therapy was successful, can be discharged after 4 to 5 days. However, from a recent paper[41] studying the evolution of LOS in the nineties from three major MI-studies (GUSTO, ASSENT), it follows that very few of the patients eligible for early discharge (more than 50%) are actually discharged within 4 days. In the most recent ASSENT-2 trial, the proportion of patients eligible for early discharge who were actually discharged within 4 days was at most 40% (USA and New Zealand). Practice patterns in European countries included in the study, as measured by length of stay, seem to be immune to conventional economic pressures, since fewer than 2% of eligible candidates were discharged early (sic).

2.4. ORGANISATION OF CARE

2.4.1. “Time is muscle”

The most critical time in an acute heart attack is the very early phase, during which the patient is often in severe pain and liable to cardiac arrest. Furthermore, the earlier some treatments, notably reperfusion therapy, are given, the greater the beneficial effect. Yet, it is often an hour or more after the onset before aid is requested. Sometimes this reflects the fact that the symptoms are not severe, or typical, or abrupt in onset, but frequently immediate action is not taken even when they are. It should be a normal part of the care of patients with known ischemic heart disease to inform them and their partners of the symptoms of a heart attack and how to respond to it.

The different time-windows concerned in the acute care of AMI are depicted in the following scheme:

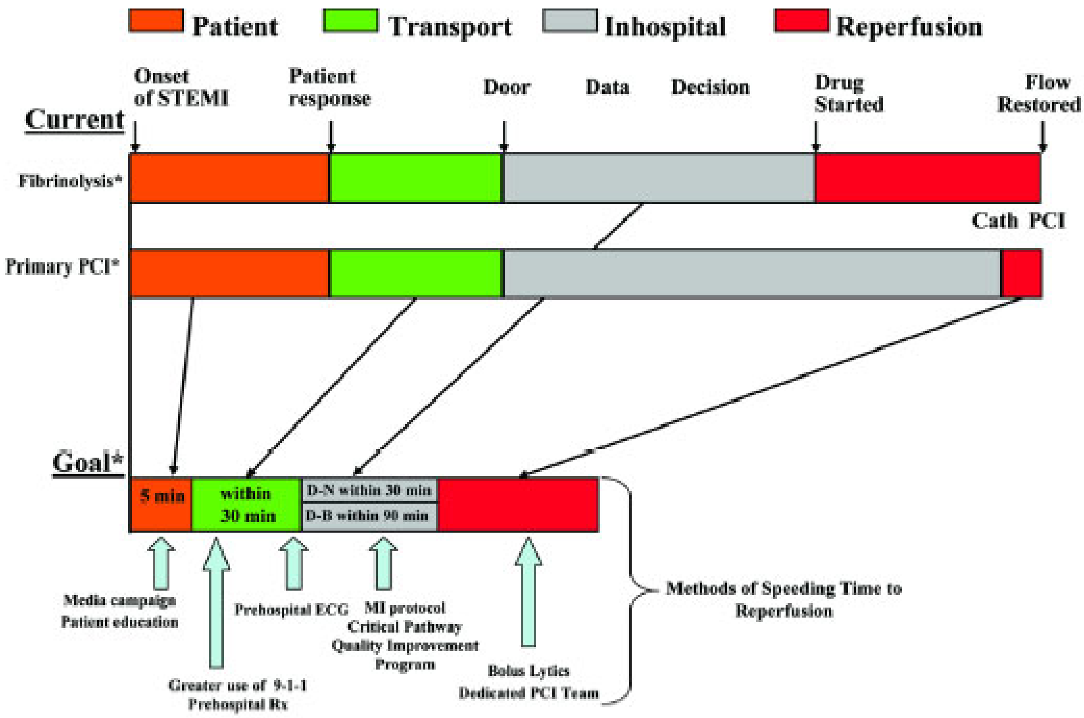


Figure 7. Major components of time delay between onset of symptoms from ST-elevation MI and restoration of flow in the infarct artery. Plotted sequentially from left to right are shown the time for patients to recognize symptoms and seek medical attention, transportation to the hospital, in-hospital decision-making, and implementation of reperfusion strategy, in time for restoration of flow once the reperfusion strategy has been initiated. The time to initiate fibrinolytic therapy is the "door-to-needle" (D-N) time; this is followed by the period of time required for pharmacologic restoration of flow. More time is required to move the patient to the catheterization laboratory for a percutaneous coronary interventional (PCI) procedure, referred to as the "door-to-balloon" (D-B) time, but restoration of flow in the epicardial infarct artery occurs promptly after PCI. At the bottom are shown a variety of methods for speeding the time to reperfusion along with the goals for the time intervals for the various components of the time delay. Cath = catheterization; PCI = percutaneous coronary intervention; min = minutes; ECG = electrocardiogram; MI = myocardial infarction; Rx = therapy. *These bar graphs are meant to be semiquantitative and not to scale. Modified with permission from Cannon et al. J Thromb Thrombol 1994;1:27-34 (180).

General practitioners play a major role in the early care of myocardial infarction as they are often the first to be called by patients. If they can respond quickly and have been suitably trained, they can be very effective, because they may know the individual patient, record and interpret an ECG, be able to administer opioids and fibrinolytic drugs.

The ambulance service has a critical role in the management of acute myocardial infarction and cardiac arrest. The quality of the care given depends on the training of the staff concerned. At the most simple level, all ambulance personnel should be trained to recognize the symptoms of myocardial infarction, administer oxygen and pain relief, and provide basic life support. All emergency ambulances should be equipped with defibrillators and at least one person on board trained in advanced life support. Doctor-manned ambulances can provide more advanced diagnostic and therapeutic skills, including the authorization to give opioids and, in some instances where pre-hospital thrombolysis is an option, fibrinolytic drugs.

The processing of patients once they arrive in hospital must be speedy, particularly with regard to diagnosis and the administration of fibrinolytic agents or the performance of a PCI, if indicated. Delays in the emergency department can be substantial; it is essential that suitably qualified staff is available to assess and treat patients with suspected myocardial infarction. Patients with clear-cut features of myocardial infarction, whom ECG demonstrate either ST-segment elevation or left bundle-branch block, should enter a 'fast-track' system, in which fibrinolytic therapy is instituted in the emergency department so that the 'door-to-needle' time is no more than 30 min or in which the patient is immediately transferred to the catheterization laboratory for PCI.

The ESC, in its 2003 guidelines, recommend to keep registers of the time from the call for care and the administration of fibrinolytic therapy ('call-to-needle' time) and that from hospital admission to reperfusion ('door-to-needle' or 'door-to-balloon' time). The former should be no longer than 90 min and for 'fast track' patients with clear indications for reperfusion therapy, the 'door-to needle' time should not exceed 20 min and the 'door-to-balloon' time should not exceed 60 min. Registers should also be kept of the proportion of patients with definite myocardial infarction admitted within 12 h of the onset of symptoms with ST-segment elevation or new or presumed new left bundle-branch block who receive pharmacological and mechanical reperfusion therapy. This proportion should probably be in excess of 90%.

There is considerable variation in treatment patterns for ischemic heart disease across Western countries. A recent OECD-report showed that much of this variation can be explained by differences in structural characteristics of health care systems, such as the payment systems, regulation and availability or restraints of technology.[42]

The regulation of expensive health care technology such as PCI and CABG and financial incentives for their use can explain in part these variations in treatment and by the differences in spending for ischemic heart disease. Higher utilisation of PCI and CABG does not necessarily mean better outcomes.[43] Most famous example is the United States, where high utilisation did not result in lower case fatality rates for the younger age group (40-64 yrs.). Reductions in IHD mortality also may not be entirely due to improvements in health care but also to reductions in underlying risk factors, such as smoking and others, which helped to reduce the overall burden of disease.[44]

In the organisation of this type of timeliness processes, high demands are put on the hospitals on the level of human resources, specialised equipment and intensive care services. Around the clock even in weekends and holidays a team of experienced cardiologists, nurses and technicians have to be available, apart from the personnel in the emergency department. For thrombolysis a well functioning emergency department and a coronary care unit is mandatory. For PCI as competing or adjunctive treatment modality, in addition, a fully equipped catheterisation lab including experienced personnel has to be operational and available for every individual patient, due to the time-critical process, in a very short time depending on minutes rather than hours and this every moment of day and night. Furthermore, several studies have described a volume-outcome relationship for PCI and CABG and most countries impose minimum criteria for training and experience of an interventional cardiologist.

In the next part, we will describe the structural characteristics and the regulation of these cardiac facilities in Belgium and their financing in comparison with other Western countries.

2.4.2. Organisation, Regulation and Financing of Cardiac Facilities

The previous OECD work showed that the two most important supply-side factors that influence the use of cardiac health care services are the methods used for paying hospitals and physicians, and how strictly facilities are regulated. There is evidence for a link between payment methods and utilisation of PCI and CABG; there are positive relationships between the availability of cardiac surgery facilities and utilisation of CABGs, and between the number of catheterisation laboratories and utilisation of PCIs.

Cost sharing can in theory give an incentive to the patient to restrict the use of health care services, especially for ambulatory care and elective surgery. However, in an emergency setting such as in acute myocardial infarction, cost sharing has a limited if any effect. Belgium is characterised as a country with low potential demand constraints: a universal public health insurance covering for most acute and ambulatory care treatment, cost sharing for inpatient services is modest and there is only a low level, if any, of gatekeeping.

On the supply side, physicians (mostly cardiologists and cardiac surgeons) are payed by a fee-for-service with a virtually open ended financing. In terms of financing of hospitals three payment systems or a mixture of them can be distinguished in OECD countries: global budget, case-mix payment systems or fee-for-service. In Belgium, a case-mix payment system, gradually being introduced, is complemented with a fee-for-service system for the physicians. The physicians most often attribute part of their fees to the hospital for the use of the hospital facilities. This type of financing provides the most direct link between activity and payment since each service has its own fee, but resource use is usually biased towards more (intensive) services since these generate the largest payments. The case-mix payment system in Belgium is based on APR-DRG. There are some concerns that DRGs are being used for not merely diagnoses but also treatments, possibly leading to more intensive treatments.[45]

A number of countries have sought to limit the diffusion of new technologies in their health care system, as a tool for cost containment and also for avoiding excess use and waste. In Belgium there are no immediate restraints to the hospitals to treat patients with acute myocardial infarction medically by e.g. thrombolytics. However, some restraints for the cardiac facilities used for revascularisation such as CABG and PCI were introduced in Belgian regulation in recent years. In 1993 a moratorium for cardiac surgery centres was put into place. A minimum of 200 CABGs per centre had to be performed annually, by this restricting a further expansion of the number of hospitals performing cardiac surgery. In 1999 the so-called 'care programs' (zorgprogramma, programme de soins) were installed by the Federal government. We refer to them under Cardiac Care Program or CCP in the present study. Virtually all acute hospitals can have a care program 'A' which basically allows clinical cardiology without limitations for non-invasive diagnostic tests or non-invasive treatments (e.g. thrombolytics). To obtain a care program 'B' for 'invasive diagnostics and therapy' a hospital needs to adhere to a number of criteria of which the most important is a quantitative one: the hospital needs to have performed 500 invasive interventions in toto. This criterion is supposed to originate from the link between quality of cardiac care and the volume of a centre.

To further complicate matters, three different types of 'B' programs exist, as depicted in table below. In a care program 'B1' only diagnostic coronarographies are performed. PCI and CABG are prohibited in the B1 hospital which means that they have to collaborate with a PCI/CABG centre. A hospital with a 'B2' program is allowed to perform PCI on the condition that at least 200 PCIs are performed by at least 2 experienced cardiologists. In a 'B3' centre, CABG can be performed. In this case at least 2 cardiac surgeons need to have performed at least 250 cardiosurgical interventions. The link between B2 and B3 is mandatory. In reality all B3 centres are also B2 and only a few exceptions exist of a lone standing B2 that works in association with a B2/B3 centre in close proximity. For both A and B programs in addition other criteria for the number and qualification of other personnel, such as nurses, exist.

Type of care program	Brief description	Number
A	Clinical non-invasive cardiology	90
B1	+ invasive diagnostics, i.e. coronarography	20
B2/B3	+ invasive treatments, i.e. PCI and CABG	29

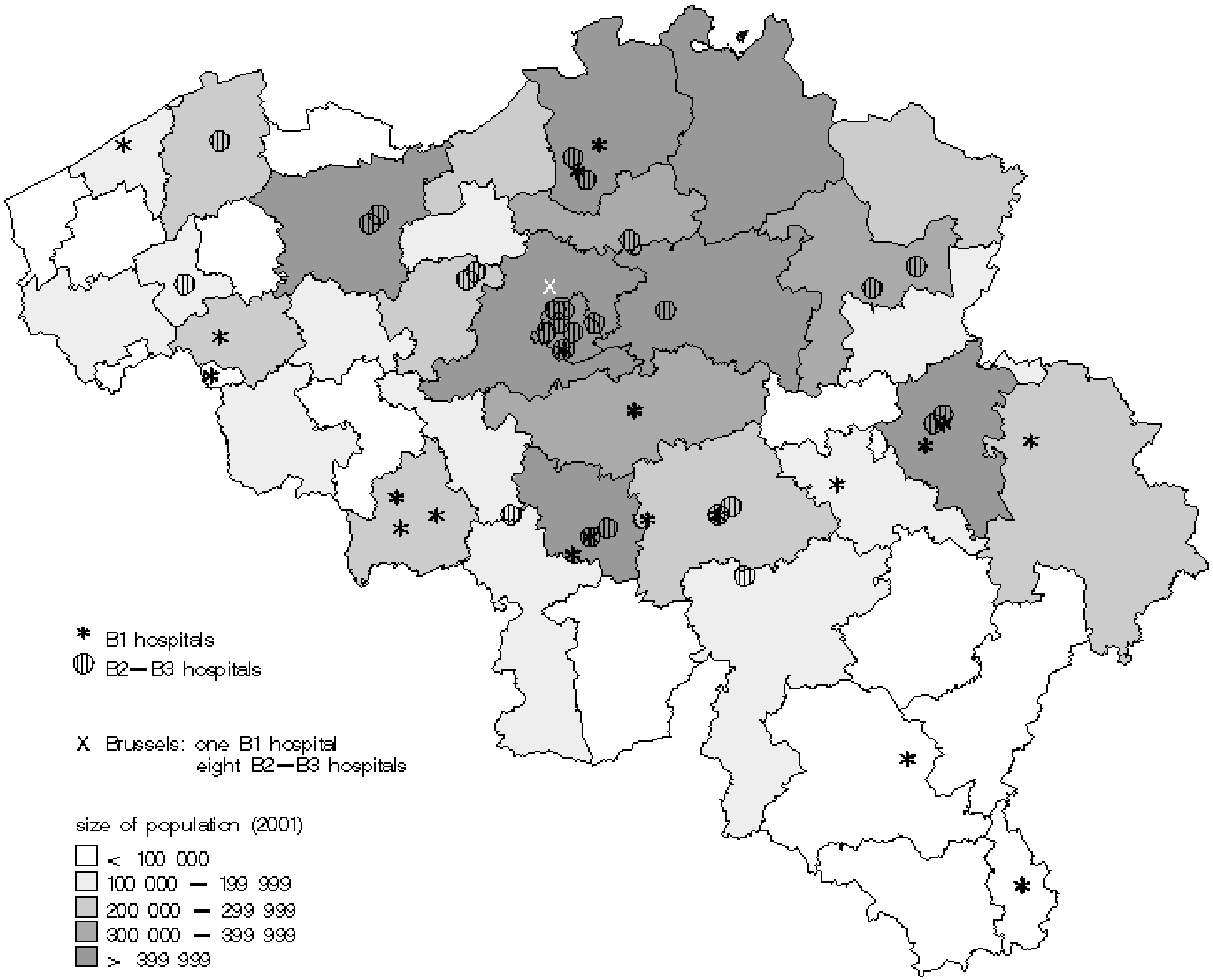
Three different types of organisation of in-hospital Cardiac Care Programs exist in Belgium. The numbers on the Belgian hospitals represent those used in this study and can vary slightly from year to year depending on e.g. the fusion of hospitals.

The authorities at the regional level (and not the federal level) check the adherence to the different criteria and transfer their report to the federal authorities. The resulting situation at the end of 2004 including certain hospitals associations is depicted in Figure 2. Names of hospitals are presented in Appendix B.

Compared to other countries, several studies of the past years show that Belgium has a high number of revascularisation facilities and a high number of interventional procedures performed, much higher than expected from the relatively low burden of ischemic heart disease.[46]

Next to the cardiac care programs A and B, other programs exist as well for pacemaker (P), electrophysiology (E), cardiac transplantation (T) and paediatric cardiology or congenital cardiac defects (C). A more detailed description of the care programs for these other diagnostic or treatment modalities is beyond the scope of this study on myocardial infarction. The high number of care programs P and E and unequal geographical spreading however, is a matter of concern for the future.

Figure 2: Belgian hospitals authorised for diagnostic cardiac catheterisation (B1) and hospitals authorised for both diagnostic and therapeutic catheterisation (B2) and B3 (CABG). Data are shown for illustrative purposes and were forwarded by the Federal Ministry of Health and with some minor adaptations by the KCE to reflect recent associations



3. METHODOLOGY

3.1. STUDY AIM AND MATERIALS

The aim of the study is to assess variability in health care use of patients with an AMI and to compare observed health care use with the guidelines formulated by the European Society of Cardiology and supported by the association of Belgian cardiologists.

The present study uses administrative databases called minimal basic data (MBD), collected at the hospital and by the insurance funds. 'Minimal' implies that only the most relevant and reliable data are collected. There are two separate databases: one with clinical data and one with costs billed to insurance companies or patients. Registration started in the eighties in teaching hospitals and was later extended to all hospitals in the country. Data collection is regulated by law and the system is fully operational since 1997. For our purposes, we used the data of 1999-2001; data from previous years (1997-1998) were used to determine presence or absence of a previous history of cardiovascular disease admissions. Mortality data were obtained from the body overseeing all insurance companies, for the same years 1997-2003. These three databases (hospital data, health insurance billing data, and mortality) can be linked to an unique individual patient code, enabling linkage between patient code, clinical data, billing data and vital status. This patient code is generated by an irreversible encryption algorithm by a third party, hiding the identity and protecting the privacy of the individual. It allows to trace all admissions of the same patient throughout hospitals and time.

In 1999, 2000 and 2001, linkage between clinical and financial data (coming from different sources) is complete for 90% of the records. Linkage between MBD and mortality is complete for 99.9% (data on file).

The administrative clinical database ("Résumé Clinique Minimum/ Minimale Klinische Gegevens" or RCM/MKG) is communicated twice a year since 1990 by each hospital to the Ministry of Public Health; all acute care hospitals must participate to this data collection. All data concerning outpatient or inpatient stay discharged during one semester must be transmitted at the end of the next semester. Information is available on age, sex, domicile zip code, length of stay, year and month of admission and discharge, in addition to all diagnoses and procedures coded in ICD-9-CM for each inpatient stay. We excluded outpatient stays.

The Ministry runs the APR-DRG grouper program to assign an APR-DRG to each stay. On the other hand, hospitals send their financial (or billing) data to the health insurers ("organismes assureurs"/"verzekeringsintellingen"). Insurers after patient anonymization, send these financial data ("Résumé Financier Minimum/ Minimale Financiële Gegevens" or RFM/MFG) to the INAMI/RIZIV (National Institute for Illness and Invalidity Insurance), using the same encryption algorithm. After a second encryption, validation and quality check by the Ministry and by the INAMI/RIZIV, the two records are transmitted to an interface body called the Technical Cell (or "Cellule Technique/Technische Cel") in order to be linked using the encrypted patient key. After matching patients the data must still be linked at the very level of each stay. Data are linked every year since discharge year 1995. Completeness of the linkage has risen from 89% in 1999, 91% in 2000 and 92% in 2001. The RCM/MKG part of the linked data gives information on the pathology and assigned APR-DRG, and the RFM/MFG part gives information on resources use during the stay.

3.2. CASE DEFINITION

In the databases, an AMI corresponds to an International Classification of Diseases (9th revision) primary diagnosis code of 410.01 through 410.91. These codes include patients diagnosed with a myocardial infarction of any location, both transmural and nontransmural. STEMI's and NSTEMI's are not considered as such in the ICD-9 coding system but they more or less correspond to transmural and non-transmural infarctions (see the remarks above) Because of uncertain and variable coding quality of the fourth digit, we took the three digit ICD-9 code 410 only.

No clinical, electrocardiographic or biochemical data were available to us and hence, there may be a substantial variability in case definitions between different hospitals and different physicians.

In Belgium troponin dosages have been reimbursed since July 1999 which may have led to an increase in the number of patients diagnosed with infarction in some but not all hospitals.

We excluded patients with a primary ICD-9-diagnosis 411 ("Other acute and subacute forms of ischemic heart disease", including "impending infarction", "preinfarction syndrome", …). In doing so, we might have missed some infarctions but the risk of injustly including false positives was much greater. For example, in the year 2001, 6213 discharges with a primary diagnosis ICD-9-code 411 were retrieved. Of these 3469 were grouped as APR-DRG 202 (stable angina), 1751 as APR-DRG 192 (cardiac cathetherisation for ischemic heart disease) and 583 as APR-DRG 175 (percutaneous interventions without MI). Only 89 of the 6213 cases were grouped under de APR-DRG 190, i.e. MI.

Cases complicated by a previous hospitalisation (this stay being a relapse), diabetes (DM) or by congestive heart failure (CHF) might necessitate more and more specific treatment. We stratified the hospitalised MI patients therefore by the presence of diuretic or inotropic treatment, the presence of a cardiovascular history and the present of anti-diabetic treatment and/or a secondary ICD code diabetes. Patients were considered as having a cardiovascular history when during the stays from 1997 preceding the index admission, they were admitted to hospital with a primary cardiovascular discharge diagnosis (codes ICD-9-CM 390 through 459). Patients were defined as having diabetes when an antidiabetic drug (oral agent or insulin – see Appendix C4) was prescribed or when they presented a diagnosis 250.xx during any admission during 1999, 2000 or 2001. Patients that received more than 20 mg furosemide or an equivalent amount of bumetanide (1 mg bumetanide corresponds to 40 mg of furosemide) were considered as having had heart failure. The number of patients receiving more than 300 mg dopamine or dobutamine during the first hospital stay was considered as an estimate of the number of patients developing cardiogenic shock. Patients receiving less than 300 mg were omitted because these were considered as having received this for diagnostic purposes (stress echocardiogram). Heart failure and shock are mutually exclusive; a patient being treated with both diuretics and inotropics was counted as "shock" and not as "heart failure".

3.3. DATABASE

3.3.1. RCM-RFM 1999-2000-2001

The criteria for a stay to be included in the linked data subset were:

- the presence of a diagnosis 410.xx "Acute Myocardial Infarction", 411xx, 412 "Old myocardial Infarction", 413.x "Other acute ischemic heart disease" or 414.xx "Other chronic ischemic heart disease" ,
- OR an assignment to the APR-DRG 174 "Percutaneous cardiovascular procedures with AMI" or 190 "Circulatory disorders with AMI",
- OR a percutaneous coronary intervention invoiced under the billing code 589024.

All stays of patients with one stay meeting the above criteria were requested. This includes a much wider selection than only the stays for acute myocardial infarction, and was necessary to determine the cardiac history of a patient, as explained above.

3.3.2. Classification : ICD-9-CM and APR-DRG's

The diagnoses and procedures registered in the clinical summary are coded following the International Classification of Disease (ICD), 9th revision, Clinical modification, published in October 1997 as far as the data used for the present study are concerned. This international classification was conceived by the American Hospital Association during the late seventies and is used in Belgium since the beginning of the registration (1990). The version is up to date following each American update, every 2 to 3 year.

The Ministry uses the APR-DRG version 15th grouper that classifies each stay in a Diagnosis Related Group. This patient classification system used by the American HCFA (Health Care financing Administration) for hospital payment for Medicare beneficiaries, was originally developed in order to relate the clinical characteristics of the patients with the health resources used during their stay. The 355 APR-DRG's are broken down into 4 levels of severity (1, 2, 3, 4 for minor, moderate, major and extreme) that represent the extent of physiologic decompensation or organ system loss of function. The severity of illness of a stay inside a particular APR-DRG derives from the combination of diagnoses, procedures (or weight for newborns) of the patient. One level of severity is meaningful inside its particular APR-DRG, but the levels of severity from different APR-DRG's cannot be grouped together or even compared.

3.3.3. Cardiac Care Program : (« Programme de soins/Zorgprogramma »)

There can be some discrepancies between the reality of the practice and the data gathered from the invoiced billing codes by the hospital. In this present study results, invoiced PCI are to be found in A or B1 hospitals that have no authorization neither infrastructure to execute such intervention. What happened actually is that patients were transported to a B2-B3 hospital during their stay at the first A or B1 hospital in order to receive a PCI in the B2-B3 hospital, but due to an agreement between both hospitals, the intervention was invoiced by the A or B1 hospital. Sometimes, physicians even practice in both hospitals, doing PCI in B2-B3 when needed. Unfortunately, the data do no allow to differentiate the invoiced of an intervention executed elsewhere from an intervention executed and invoiced on the same location

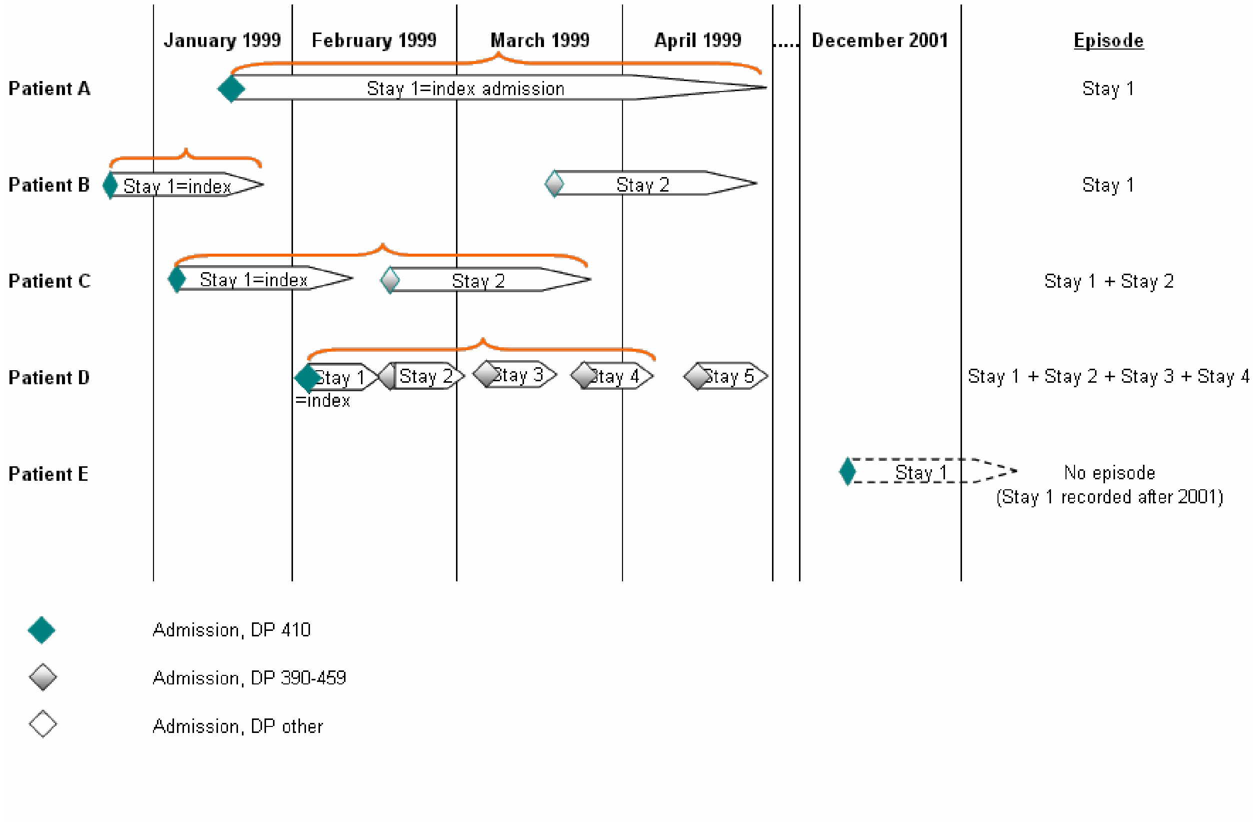
3.3.4. Stays, Patients and Episodes

After an infarction, one patient may stay 'i' stays in 'j' hospitals during 'k' months after that infarction. Stays are therefore an incomplete description of a disease episode, as treatment may necessitate transfer to better equipped hospitals. Unfortunately, for privacy reason coupled data do not include admission and discharge days but only admission and discharge months. Since patients suffering from AMI might re admitted in an hospital and then transferred to another one for the same care episode, an "Episode of Care" was approximated from the available data. A first episode is therefore defined as all consecutive cardiovascular stays following the first stay in the same month or in the next month following the admission for Acute Myocardial Infarction, regardless of cardiovascular history, with a maximum of 4 stays per episode. The time horizon of an episode takes in all admissions over a mean period of 45.5 days (range 28 – 62).

The first stay of the Episode of Care is called "Index Admission".

To illustrate these definitions, Figure 3 shows a few examples of possible scenarios.

Figure 3: Examples of Episodes of Care



3.4. MANAGEMENT OF AMI

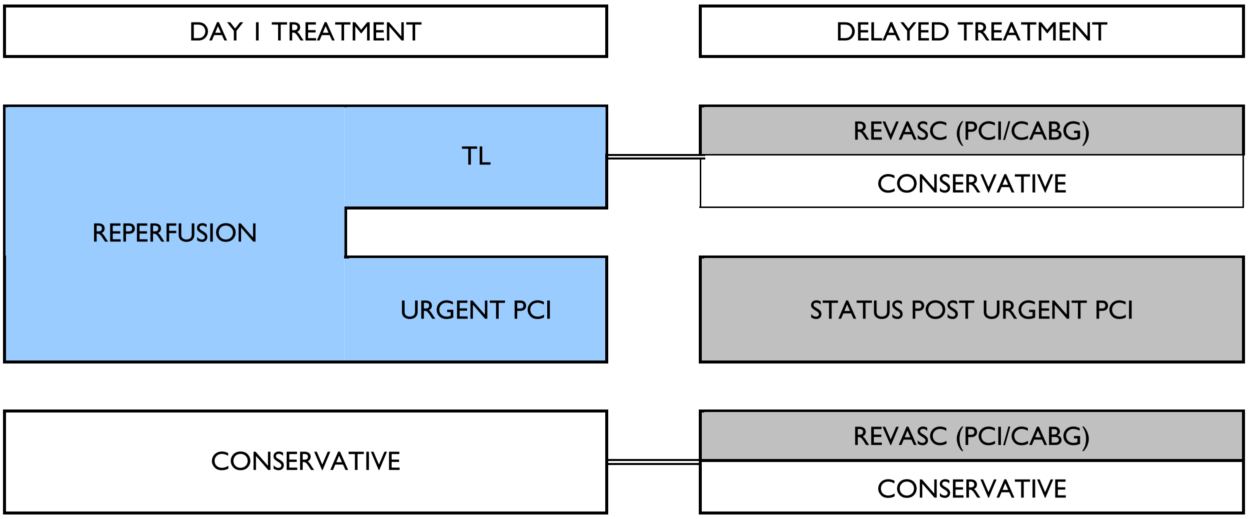
3.4.1. Treatment aimed at the Infarct Related Artery

For the current report we ought to discuss the combined management of STEMI and NSTEMI whereas in clinical practice, treatment is different in both types of AMI. Especially the use of thrombolysis and primary PCI are essentially different in both clinical pictures. Therefore, we constructed a "virtual care pathway" combining the treatments of both types of infarctions.

Limiting infarct size is one of the major immediate concerns in treating patients with AMI. In STEMI this is aimed at by reperfusion of the infarct related artery (IRA) which is completely blocked by thrombus. In a chemical or mechanical way, the thrombus inside the blood vessel is resolved or removed resulting in a recanalization of the IRA. In NSTEMI there is also thrombus inside de IRA which does however not completely block blood flow through that vessel. Here, thrombolysis is no therapeutic option but sooner or later PCI can be performed in patients with ongoing ischemia or with hemodynamic troubles. In this paper we use the general term "reperfusion" for emergency recanalisation of the IRA, i.e. recanalization on the calendar day of admission, by means of thrombolysis or urgent PCI.

For various reasons, in some patients reperfusion is not contemplated and they are treated conservatively[a]. In STEMI this can occur for example because of late presentation (> 12 hours from onset of pain), because of contraindications to thrombolysis, unavailability of emergency invasive treatment, …. In NSTEMI conservative treatment is generally advocated when there is good response to medical treatment.

[a] « Conservative » is defined as not being treated with percutaneous intervention neither thrombolytics.



Following the acute event, the medical care of the MI patient addresses the treatment of complications of the infarction and assesses risk factors for future cardiac events. By instituting medical therapy and by revascularizing ischemic regions of the heart, long term prognosis can be improved. Thrombolysis in a number of patients constitutes the final "vascular treatment" but some patients later on will need an angioplasty of the IRA. Urgent PCI on the other hand in most cases can be considered both as an acute and a final therapy because not only the occluding thrombus is removed but, by means of the accompanying PTCA and/or stenting, the underlying vessel stenosis is dilated. Depending on the clinical evolution, some patients initially treated conservative will be treated with PCI or CABG later on.

Urgent PCI was identified by a procedure coded 36.01, 36.02 or 36.05 in MCD, performed on the first day of the index admssion. Urgent CABG was identified with the code 36.1x:

We define revascularization as the sum of all PCI and CABG.

The codes in the MFD seleted to identify the PCI and CABG are in Appendix C2.

3.4.2. Diagnostics and Drugs

Diagnostics

The diagnostic techniques were analyzed from the billing codes published by the INAMI/RIZIV, used for the invoice procedure to get reimbursement by the health insurers of the patients and recorded in the MCD/MFD. The ICD-9-CM coding is considered to be less reliable than the invoice data. Therefore, we did not consider the MCD in order to analyze the diagnostics, but well the MFD. The codes used to select the diagnostics in the MFD are in Appendix C1.

The diagnostics considered include:

- Ambulatory 24-hour-ECG Monitoring
- Ambulatory 24-hour-ECG Monitoring without full disclosure
- Angiocardiography
- Aortogram
- Cardiac Radionuclide imaging
- Carotid duplex ultrasound
- Chest X-Ray
- Coronary angiography (CAG)
- ECG-Monitoring

- ECG-Monitoring, combined with invasive monitoring of blood pressure A/O central venous pressure
- Echocardiography
- Electrophysiological study (EPS)
- Ergospirometry
- Exercise testing
- Invasive hemodynamic monitoring (Swan-Ganz)
- Pharmacodynamic ECG testing
- Pulmonary diffusion capacity
- Residual lung volume
- Respiratory minute volume
- Rest ECG
- Study of ventilation mechanics
- Transoesophageal echocardiography (TEE)
- Vectorcardiogram

As a PCI must be preceded implicitly by a CAG, an invoiced PCI automatically implies that a CAG was done, even if the CAG is not recorded in the financial data in the database. To obtain the number of patients with a CAG, patients were counted once; whether they had a CAG, or a PCI. The number of invoiced CAG and the number of invoiced PCI were added in order to obtain the total number of CAG performed.

Beta-blockers

A patient was considered being treated with a beta-blocker (BB) if he or she received at least one dose (oral or intravenous) of any product belonging to level 2 C07 (beta-blocking agents) from the Anatomical Therapeutic Chemical (ATC) classification. The complete list of reference products is in Appendix C3. We studied the percentage of patients who received beta-blockers per hospital.

Based on the available administrative data, we could not differentiate between patients who received BB for other reasons such as arterial hypertension or arrhythmias and we do not know how many patients were not taking these drugs because of contra-indications.

Other drugs

We analyzed the percentage of patients that have received abciximab (ATC5= B01AC13) as anti-platelet agent. The only brand product in Belgium was Reopro©, reimbursed since March 1999. We could not analyze the consumption of tirofiban since this product was not reimbursed before February 2002 (and hence not present in the drugs invoiced data). Eptifibatide does not belong to the Belgian pharmacopeia.

We were not able to investigate prescription practice for other agents like statins, ACE-inhibitors and antiplatelet agents, because these are subject to different reimbursement strategies, making it impossible tracing their use.

3.4.3. Definition of a Homogeneous Group of Patients (Low Risk Group)

In order to avoid as much as possible outcome and resource use differences due to case-mix when comparing hospitals, we defined a uniform low risk patient group that we presumed could be used to this end. As we did not have access to clinical data and the Belgian registration system of secondary diagnoses does not distinguish between complications and comorbid conditions present at hospital admission, we could only use a limited set of administrative data. The "low risk history and alive at the end of the episode" – in shorthand "low risk" - population consisted of all patients < 75 years old, without diabetes and without cardiovascular history who were alive at the end of the episode and who were grouped at discharge in Major Diagnostic Category 5. We included the latter in our definition to exclude a limited number of patients with ill-defined and complex or "non-groupable" medical problems (e.g. patients that underwent tracheostomy, transplantation, surgery that was not related to the cardiac event, ….).

3.5. DATA ANALYSIS

3.5.1. Standardization Method (maps)

When presenting maps with incidence rate and mortality in order to make comparisons, we need to adjust for differences in age and sex district composition. Since the highest age-specific mortality rates occur at the youngest and oldest age cohorts, populations with large child and elderly populations will have higher mortality rates. In order to eliminate this influence, we computed direct standardized death rate and direct standardized incidence rate by applying the rate of each age/sex group at the standard population, being the Belgian population of each age/sex group. The mortality rate for example becomes thus a weighted average of the district age/sex-specific mortality rates where the weights represent the age/sex-specific sizes of the standard population.

3.5.2. Boxplots

The boxplot we choose to use to represent the distribution of some variations between hospitals include 50% of the observations (between lower and upper quartiles) in its square: the height of the box equals the interquartile range (IQR). The two whiskers (or vertical bars departing from the square) are drawn down till the last observation below Q1(first quartile) - 1.5xIQR and up above Q3 (third quartile) + 1.5xIQR. The possible outliers outside those boundaries are located outside the box and indicated with an asterisk. The mean is represented by a "+" sign and the median is the horizontal line dividing the box in 2 (if the median is different from Q1 or Q3).

Unless specified, the tables and figures showing inter-hospital variability are always computed on hospitals with at least 10 stays (or 10 patients).

3.5.3. AMI Incidence Rates

AMI incidence is here defined as a first occurrence of cardiovascular disease in our database, starting in 1997. Patients in 1999 have a shorter "look back" period of only two years; incidence is slightly more polluted with recurrences; after three years of look back there was little effect anymore. Recurrent AMI rates are those AMI that occur after a previous AMI. Attack rates are all AMI observed, both incident and recurrent AMI.

3.5.4. Consumption Index

The purpose of the Consumption Index is to identify hospitals that use particularly many diagnostic techniques. In order to define this index than can be considered as indicating overconsumption, we selected ten techniques that are not routinely recommended in low risk MI by guidelines but nevertheless were commonly used and that are available in most hospitals. We assigned 1 point to each technique, each time it was used. A consumption index was built summing all the points.

The following diagnostic techniques were taken into account for the Consumption Index:

- Ambulatory 24-hour-ECG Monitoring (full disclosure)
- Carotid duplex ultrasound
- Invasive hemodynamic monitoring (Swan-Ganz)

- Pharmacodynamic ECG testing
- Pulmonary diffusion capacity
- Residual lung volume
- Respiratory minute volume
- Study of ventilation mechanics
- Transoesophageal echocardiography (TEE)
- Vectorcardiogram

Two diffferent points of view were considered.

Firstly, we examined the variation between hospitals and between Cardiac Care Programs. Since we considered only the Low Risk part of the population, major differences were not to be expected between them. In order to keep comparison simple, we limited ourselves to consumption in Low Risk patients with a one and only “single stay”. In the appendix a more complicated approach is presented. Because a patient can spend several stays in several hospitals, the consumption index was computed for each stay of the episode. Then, the mean of the index of all stays spent in each hospital gives a mean consumption index for each hospital.

Secondly, from the patient point of view, a consumption index was computed for each patient, counting the points across his whole episode. A map was drawn, in function of the patient domicile district. Without pointing out at any hospital in particular, this approach has the advantage to encompass the complete episode of care administered to the patient.

3.5.5. Global and Partial Bill

All the amounts below are presented from the Social Security System point of view, they are the reimbursements paid to the hospitals following the fees for medical services as legally published by the INAMI-RIZIV (National Insurance Institute for Illness and Disability). The part supported by the patient is not included in this analysis. The reimbursed costs per patient include the all-in price paid per day of stay, and the reimbursed amounts for all medical acts and supplies as drugs, implants, blood, etc. As the clinical biology all-inclusive price was registered in the RFM/MFG only since 1 January 2001, the costs were calculated without these amounts to avoid a bias between 1999, 2000 and 2001. These amounts represented 3.5% of the total bill in 1999. As the length of stay has a direct implication on the price per day amount which is not the same from a hospital to another, we will present the bill with and without the all-in or hospital day price.

3.5.6. Multilevel Analysis of LOS

To estimate the within hospital and between hospital variability in the LOS of the index admission, a multilevel model has been fitted to the LOS data of the Low Risk Group patients with a single stay episode, i.e. patients that have not been transferred or readmitted after their first stay. The same multilevel model has been fitted separately for each CCP.

The multilevel modelling is a powerful methodology that deals with hierarchical data, i.e. units (level 1) that are grouped into clusters (level 2). In this case, the level 2 units are the hospitals and the level 1 units are the patients. As only patients with a single stay episode of care are considered, each patient has been treated by one specific hospital only (simple hierarchical structure). More complex models (such as multiple membership models) can deal with situations where patients have been treated by several hospitals, but as these methods are not yet available in standard software, they have not been investigated further.

To model the LOS data, a stepwise approach has been performed (as described by [47]), which fits sequentially models of increasing complexity, from an empty model (model without any covariates) to models containing both patient and hospitals covariates. The methodology is described in details in Appendix H.

3.5.7. Mortality

Mortality data were available from 2 sources: in hospital mortality from clinical database and long term mortality from the health insurers database, containing only the month and year of death (the exact date of death is unknown).

The mortality has been described at several time points, which are defined below;

- Day 1 Mortality = death during the index admission and length of stay is 1 day.
- In hospital mortality = death in hospital during the episode of care.
- Short term mortality = death within the same calendar month of the index admission or during the following calendar month.
- Long term mortality= death during the follow-up period.

Descriptive summary statistics on short and long term mortality are presented, for all patients and for specific subgroups of patients based on baseline characteristics (age, sex, district of residence, …). A multivariate logistic regression model has been fitted to the short term mortality data with the following factors; age (as a covariate), gender, cardiovascular history and diabetes. Odds ratio and 95% CI were derived from that model. To assess the influence of the CCP of index admission on the outcome, the same logistic model with CCP factor has been run. As CCP is a characteristic of a hospital, and not of a patient, and because patients are clustered by hospital, it has been shown that "traditional" logistic regression, assuming complete independence among all patients, tends to underestimate 95% CI associated with the hospital effect. To take into account the correlations that may exist between different patients from the same admission hospital, the GEE approach [Generalized Estimating Equations] has been used [[48]].

To assess the long term mortality, methodology for survival analysis has been used [49]). As only the month of death is known (and not the exact date), survival function is estimated by the Life-Table method, on all patients and stratified for baseline characteristics factors. To assess the influence of other baseline characteristics on the long term survival, a Cox PH model applied to data grouped by interval (interval-censored data) has been fitted ([50]). Factors included in the model are time (grouped by 3 months intervals to reduce the number of parameters in the model), gender, age, history of cardiovascular disease and history of diabetes. Hazard ratio and 95% CI were derived from that model. The same model was used to assess the influence of CCP on the long term mortality.

4. RESULTS

4.1. OVERALL DATA DESCRIPTION (ALL PATIENTS)

4.1.1. Stays, Patients and Episodes

A total of 34961 patients discharged with a principal diagnosis of Acute Myocardial Infarction (ICD-9 410) in 1999, 2000 or 2001 were identified in the linked clinical-financial database. After identification of these patients, their episode of care was constructed (as explained in methodology section 3.3.4.), resulting in the selection of 53291 hospital stays. The episode of care of the 34961 patients is described in Table 1. The majority of patients (63.4%) had a single stay episode of care, meaning that these patients were not transferred or readmitted in an hospital for a cardiovascular reason, within two months of their first admission for AMI (AMI index admission). Another 23.3% of patients had 2 hospital stays during their episode of care (mainly a transfer to another hospital, or a readmission to the same hospital). Some patients had a 3-stay episode of care (mainly patients transferred to another hospital for an invasive procedure and then transferred back to the index admission hospital). Very few patients (2.5%) had a 4-stay episode of care.

Table 1 : Description of Episodes of Care: Patients and Stays

	N	%
Number of Stays in Episode of Care	Patients	% of Patients
One Stay †	22168	63.4
Two Stays	8140	23.3
Three Stays	3769	10.8
Four Stays	884	2.5
All Patients	34961	100
Chronology of Stay in Episode of Care	Stays	% of Stays
Index Admission	34961	65.6
Second Stay	12793	24.0
Third Stay	4653	8.7
Fourth Stay	884	1.7
All Stays	53291	100

† These patients are called “single stay episode of care patients” in the rest of the report.

From these 34961 patients, 13868 (39.7%) were younger than 75 years, had no cardiovascular history, no diabetes, had an index admission APR-DRG in the Major Diagnostic Category 5 (Diseases and Disorders of the Circulatory system) and were alive at the end of their episode. These patients form the “Low Risk Group”, which is studied extensively in the section on variability of AMI management between hospitals.

4.1.2. Description of Index Admissions

Baseline Demographics of Index Admissions

On the 34961 patients admitted for AMI, 66.4% of patients were male. Their mean age at first admission was 67.8 years (64.7 years for males, 73.9 years for females). Figure 4 presents the population pyramid for these patients.

20.3% of the patients had a cardiovascular history, and 24.8% a diabetes. These baseline characteristics are presented by age group in Figure 5. Full details are provided in Appendix D3.

Figure 4: Population Pyramid

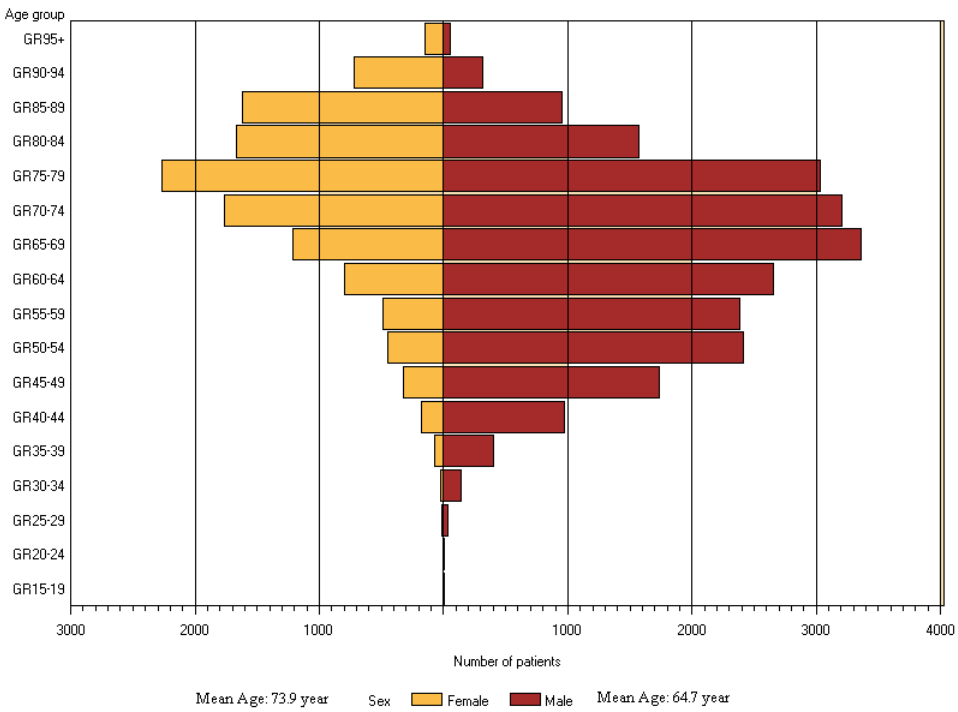
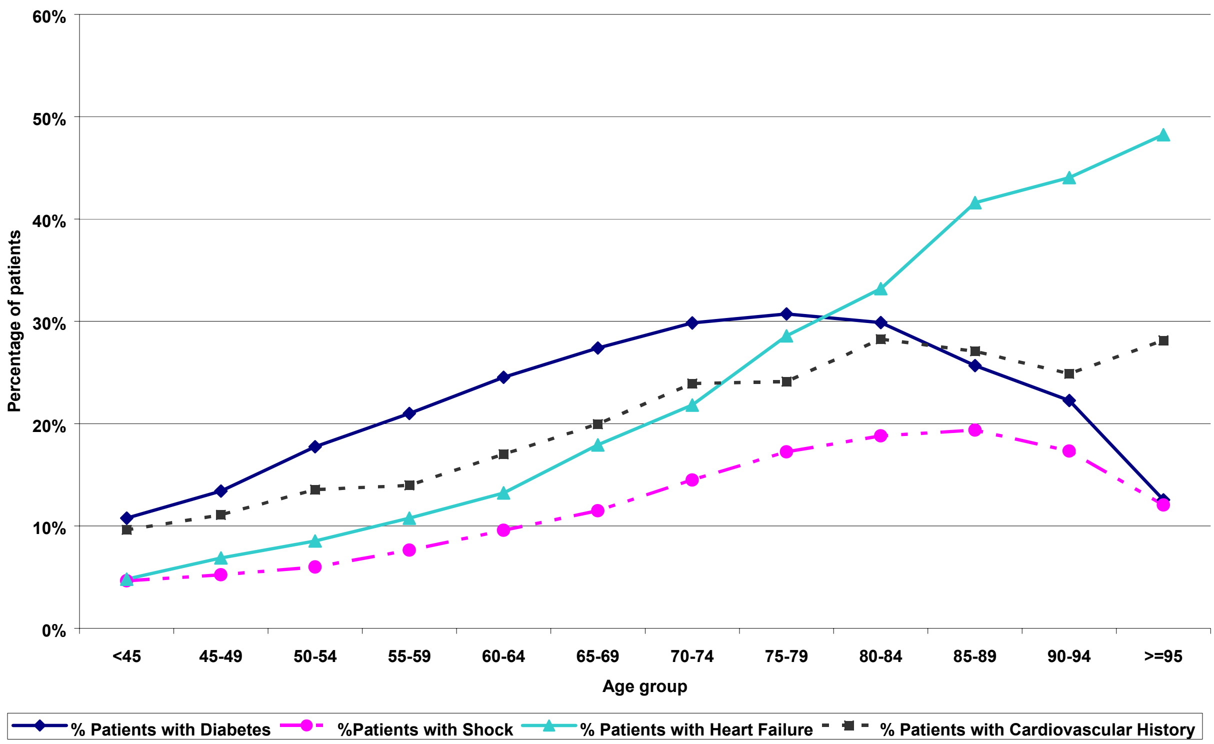


Figure 5 : Baseline Patient Characteristics by Age Group



Index Admissions by APR-DRG

Of the index admissions for 34961 patients, 34586 (98.9%) belong to the Major Diagnostic Category (MDC) 5: Diseases and Disorders of the Circulatory system (APR-DRG classification). The remaining stays belong to APR-DRGs not belonging to MDCs 5: APR-DRGs 950, 951, 952 (procedures unrelated with principal diagnosis, 205 patients), ungroupable APR-DRG 956 (37 patients), APR-DRG 004 Tracheostomy (131 patients) or APR-DRG 002 Heart/and or Lung transplant (2 patients).

Table 2 gives the four more frequent APR-DRGs. All data are presented in Appendix D1.

Table 2 : Most Common APR-DRGs of Index Admissions

MDC	APR-DRG			Percentage per severity of illness of APR-DRG			
		Total	%Total	1	2	3	4
05	190 Circulatory disorders with AMI	24317	69.6%	22%	49%	18%	10%
05	174 Percutaneous cardiovascular procedures with AMI	5520	15.8%	37%	41%	14%	8.0%
05	207 Other circulatory system diagnoses	2654	7.6%	38%	32%	22%	8.3%
05	165 Coronary bypass without malfunctioning, with cardiac catheterization	636	1.8%	0.5%	26%	47%	26%
	Others	1834	5.2%				
	TOTAL	34961	100%				

Incidence Rates of Index Admissions in Belgium

There were 34 961 patients admitted with a principal diagnosis of acute myocardial infarction for the 3 years from 1999 till 2001 in the linked database, that is 11 654 patients per year, or 114 patients per 100 000 inhabitants and per year. Completeness of data linkage for all inpatient stays in Belgium from 1999 till 2001 varies from 89% to 92% ; on the other hand uninsured patients (in limited number in this country) do not have billing records. Our data therefore give a slightly underestimated ratio of the real incidence rate of first AMI admission.

Figure 6 presents the incidence rate of first AMI admission, by district of patient's main residence, for
100 000 inhabitants, and standardized for age and sex.

Figure 7 presents the incidence rate of first AMI admission, by gender and age category. Overall, incidence rates are higher for women than for men, and rise with the age of the patients. Figure 7 also presents the incidence rate, defined as rate of first AMI admission, for patients without cardiovascular history.

Figure 6 : Number of first AMI Admissions per 100.000 Inhabitants per District for 1999-2001 (standardized per age and sex)

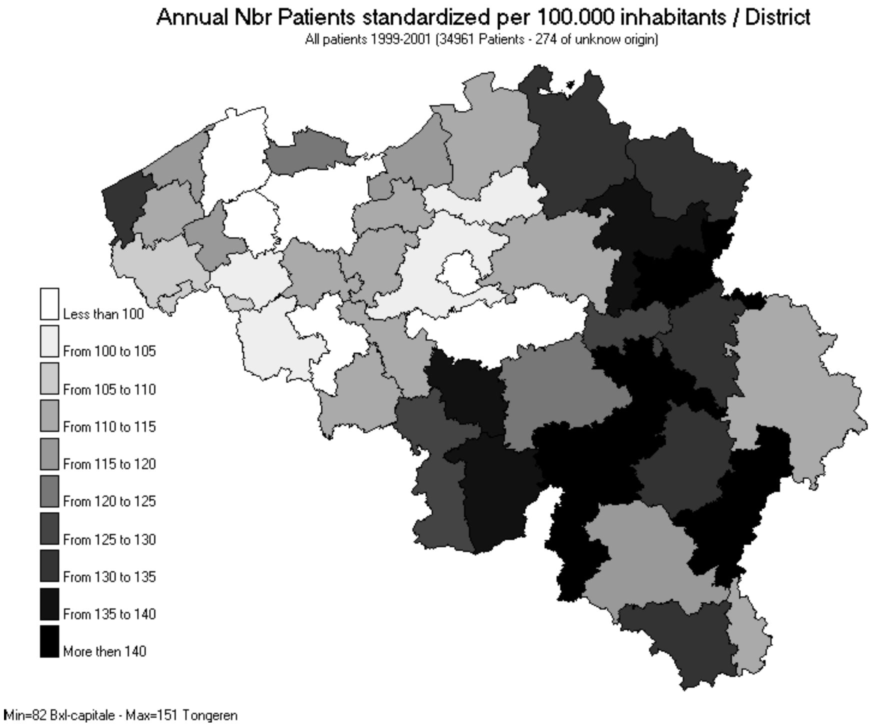
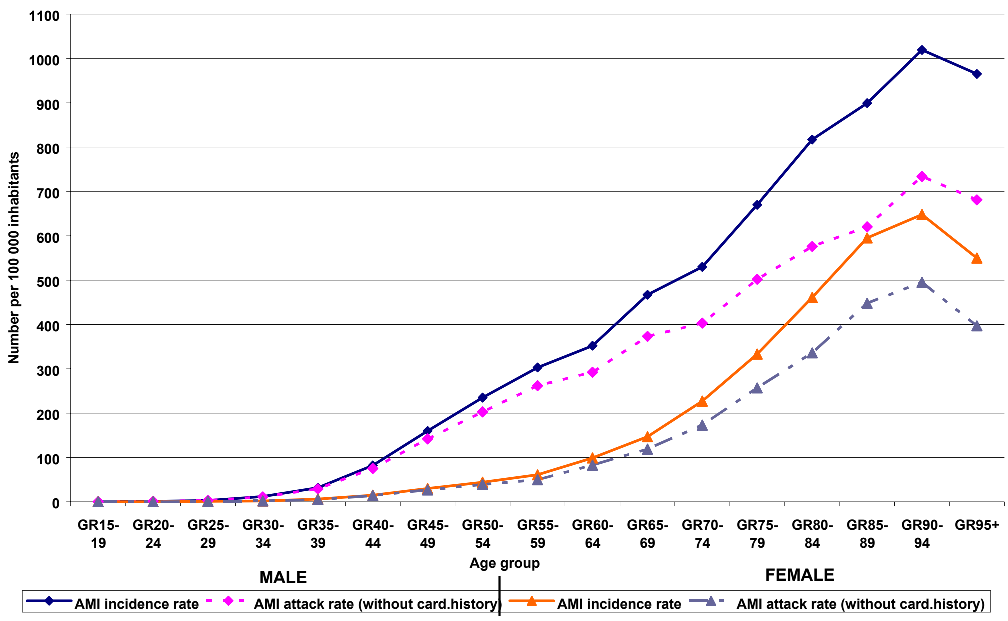


Figure 7 : Incidence Rate of First AMI Admission (1999-2001) by Sex and Age group, for 100.000 inhabitants



4.1.3. Treatment Histories

Overall Treatment of Acute Myocardial Infarction

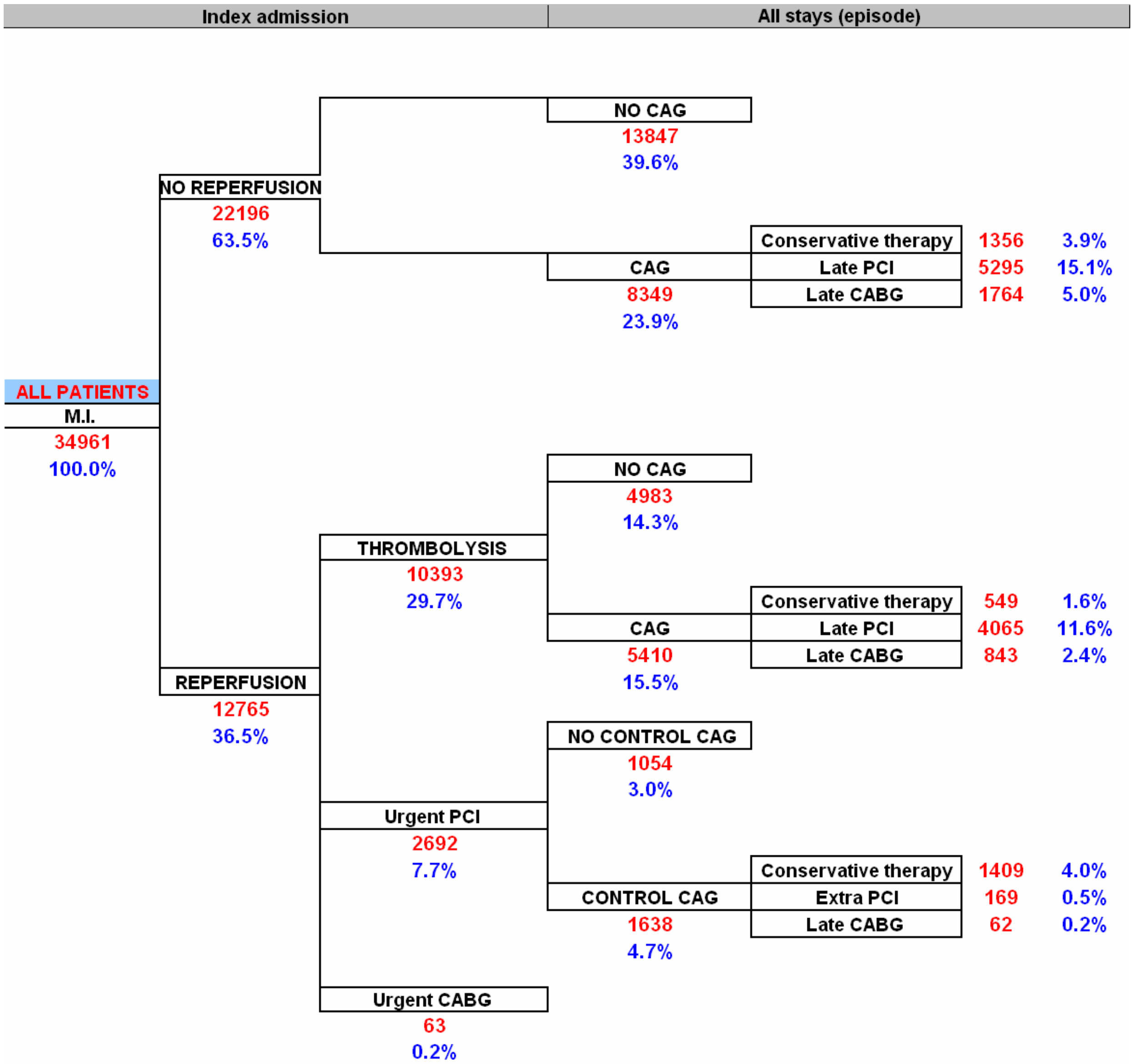
As discussed in chapter 3, we constructed a "virtual care pathway" combining the treatment of both STEMI and NSTEMI, with special consideration of reperfusion and revascularization. The following chart summarizes the therapeutic pathway which our total patient population went through. The number of patients following a certain pathway is written next to each box, with their respective percentage below. A patient receiving more than one of the treatment modalities, is classified in each of them, the three possibilities being not mutual exclusive.

A patient treated by thrombolysis, urgent PCI or urgent CABG is allocated to the reperfusion branch of the flow chart (36.5% of the patients). Reperfusion was accomplished in 29.7% of patients with thrombolytics, in 7.7% by urgent PCI and in 0.2% by means of CABG. 63.5 % of patients did not receive reperfusion therapy.

The next step along the pathway considers further invasive investigations and treatment modalities. Of the 22196 patients that did not receive any reperfusion treatment 8349 underwent later on a CAG, resulting in 5295 PCI's and 1764 CABG's.

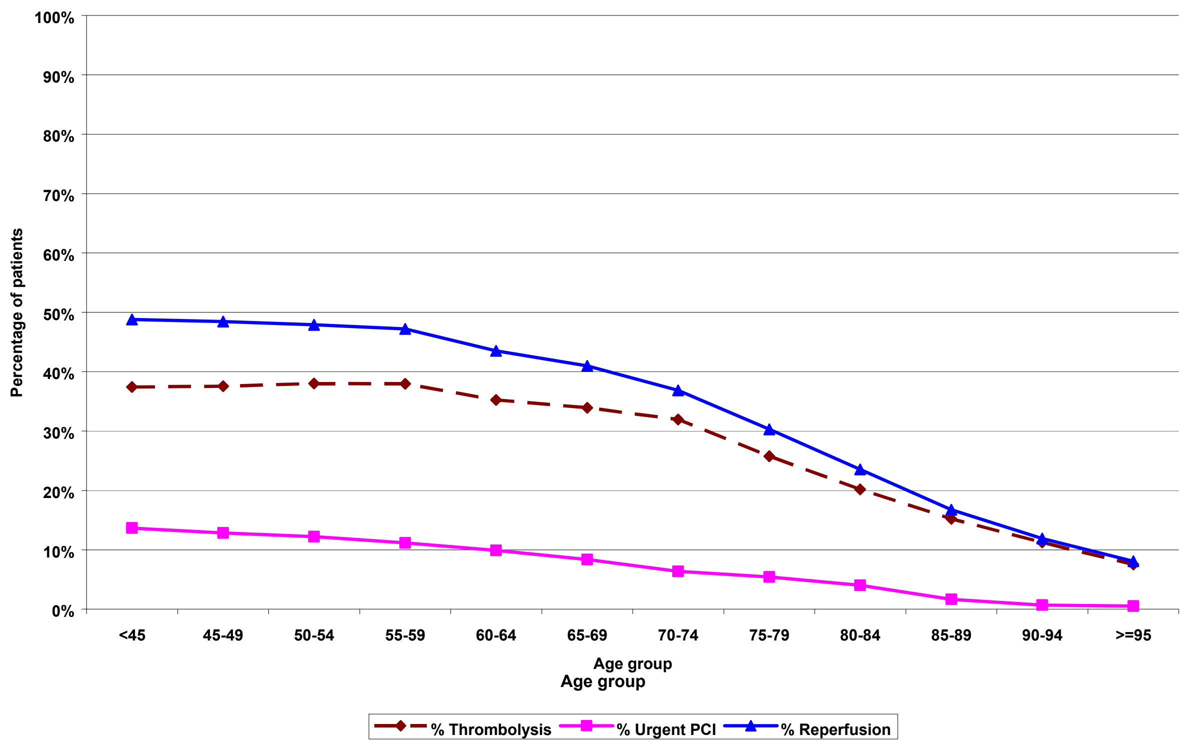
Following thrombolysis, 5410 patients underwent CAG, resulting in 4065 PCI's and 843 CABG's. Following P-PCI, 1638 patients underwent a control angiography, resulting in only 169 of them in a second PCI and in 62 patients in a CABG.

Figure 8: AMI Treatment during Index Admission and Episode of Care.



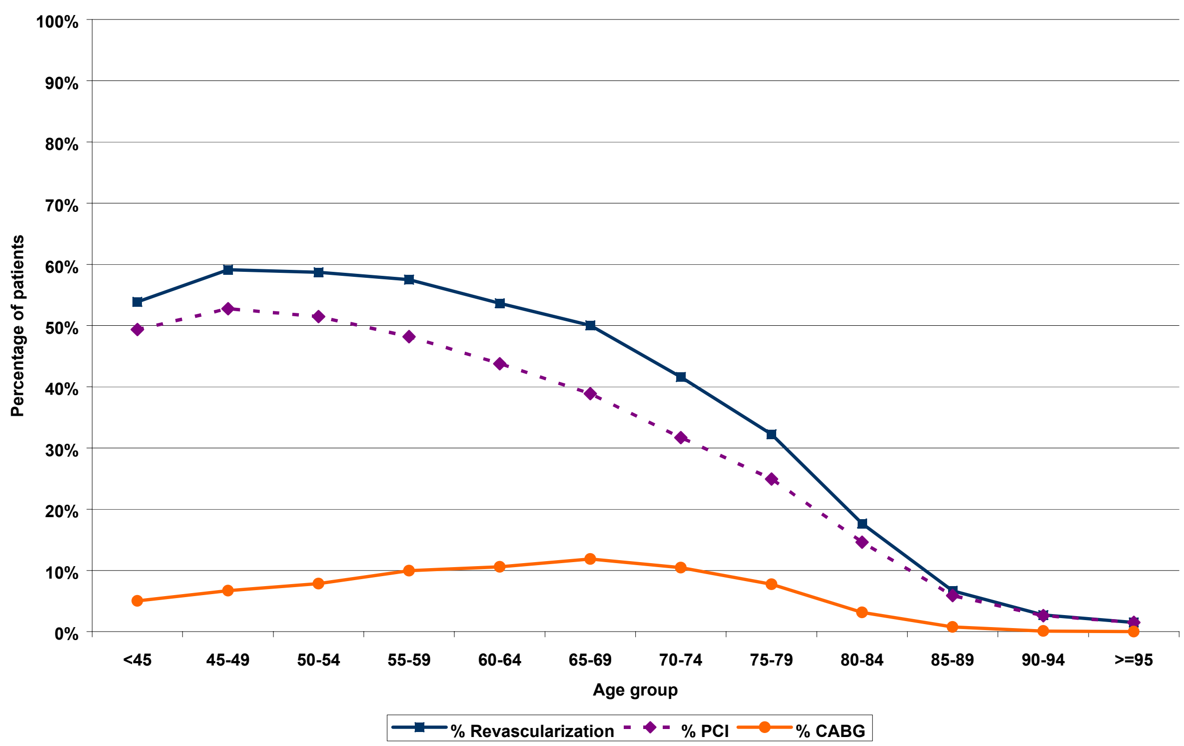
A total of 36.5% of patients were reperfused during their index admission stay. Figure 9 presents these data by type of reperfusion and age group.

Figure 9 : Patients Reperfused by Type of Reperfusion and Age Group



A total of 40.7% of patients were revascularized during their episode of care. Figure 10 presents these data by type of revascularization and by age group.

Figure 10 : Patients Revascularized by Type of Revascularization and Age Group



Hospitals and Cardiac Care Program

A total of 34 961 patients were discharged with a principal diagnosis of AMI in 1999, 2000 and 2001. These patients were treated in 158 hospitals for their episode of care: 109 hospitals in the Cardiac Care Program A, 20 hospitals in the B1 and 29 hospitals in the B2-B3. There are only 139 hospitals with index admissions, as 19 hospitals from the A treated patients after their index admission, but admitted no patient with a first AMI diagnosis during the study period (1999 to 2001).

Table 3 presents the number of index admissions and the number of stays per hospital from all 34961 patients. If a majority of patients are first admitted in A (64.7%), the readmissions during the episodes give a greater role to B2-B3 hospitals (46.5% of all stays were treated in this CCP).

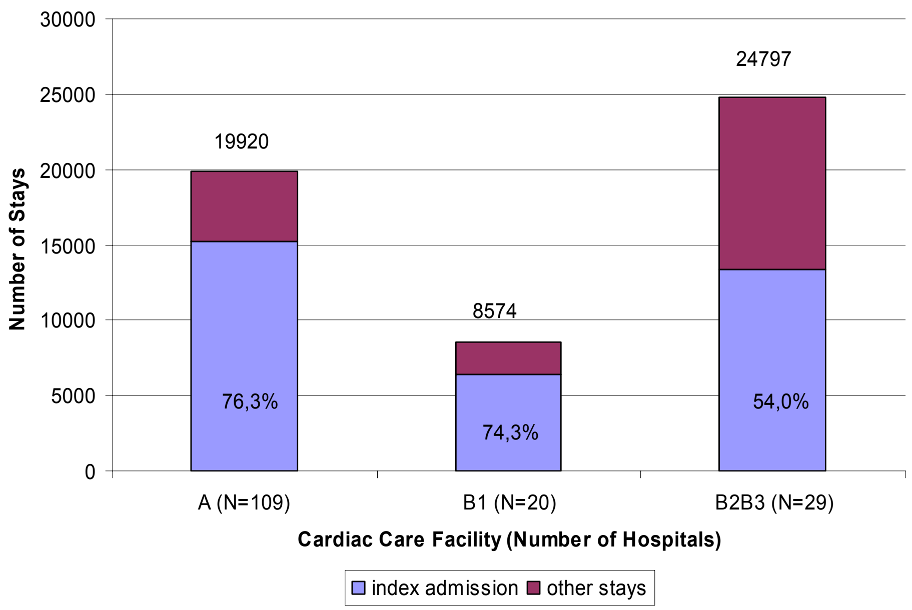
Table 3 : Number of Index Admissions and Number of Stays per Hospitals, per CCP.

	Index admissions				Stays			
CCP	N hospitals	% hospitals	N Index admissions	% index admissions	N hospitals	% hospitals	N stays	% stays
A	90	64.7%	15205	43.5%	109	69%	19920	37.4%
B1	20	14.4%	6367	18.2%	20	12.7%	8574	16.1%
B2-B3	29	20.9%	13389	38.3%	29	18.4%	24797	46.5%
ALL	139	100%	34961	100%	158	100%	53291	100%

All hospitals are included.

Figure 11 shows the total number of stays in each CCP, and the percentage of these stays which are index admissions (first stay of episode of care). While the majority of stays in A and B1 are index admissions (76.3% and 74.3% respectively), stays in B2-B3 index admissions represent only 54% of all the stays in patient's episode of care.

Figure 11: Number of Stays by CCP (Index Admission or Following Stays)



% = % of stays which are index admissions (first stay),

All hospitals are included.

Baseline Demographics of Index Admissions by Cardiac Care Program

Baseline patient characteristics are presented by Cardiac Care Program of index admission in Table 4. A patient transferred from one CCP to another is counted only once in this table (in the CCP of admission).

There are small observed differences between patients admitted first to a hospital in the A, B1 or B2-B3. Mean age was 68.8 for patients first admitted to a A hospital, 67.9 for B1 and 66.4 for CCP B2-B3. There were, respectively, 65.8, 65.1 and 67.8% male patients in A , B1 and B2-B3. Other baseline characteristics are presented in

Table 4. The main differences between patients admitted into different CCP relate to the number of stays in the episode of care and the APR-DRG of first admission. While the majority of patients admitted in a CCP B2-B3 hospital have a single stay episode of care (78.8%), this is the case for 52.7% and 56.6% of patients first admitted to a A or B1 hospital. Also, the majority of index admissions stays belongs to APR-DRG 190 in A (80.4% of patients) and B1 (89.8%), which is not the case in B2-B3 (47.7% APR-DRG 190, 38.7% APR-DRG 174).

Table 4 : Baseline Demographics Characteristics by Cardiac Care Program of Index Admission

		Cardiac Care Program of Index Admission			
		A	B1	B2-B3	All Patients
Total Index Admissions (Count)		15205	6367	13389	34961
Age Mean (SD)		68.8 (13.3)	67.9 (13.8)	66.7 (13.7)	67.8 (13.6)
Male Patients (%)		65.8	65.1	67.8	66.4
Cardiovascular History (%)		19.4	19.9	21.4	20.3
Diabetes (%)		24.3	26.0	24.8	24.8
Number Sec Diagnoses Mean (SD)		4.1 (3.4)	6.0 (4.2)	5.7 (4.4)	5.1 (4.0)
Sec Diagnoses > 4 (%)		34.9	56.8	52.9	45.8
Pump Failure (%)	Heart Failure	21.6	20.9	20.4	21.0
	Shock	11.1	12.2	14.4	12.5
Included in Low Risk History Alive population (%)		39.1	38.5	40.9	39.7
Single Stay Episode Patients (%)		52.7	56.6	78.8	63.4
Single Hospital Patients (%)		57.3	63.4	91.1	71.4
APR-DRG (%)	165 (CABG)	0.1	0.0	4.7	1.8
	174 (PTCA with AMI)	1.5	1.7	38.7	15.8
	190 (circulatory disorders with AMI)	80.4	89.8	47.7	69.6
	207 (other circulatory disorders)	14.5	3.7	1.6	7.6
	other	3.5	4.8	7.4	5.2

AMI Treatment by Index Admission in Cardiac Care Program

The treatment received during index admission and during entire episode of care, is presented by CCP of index admission. The percentage of patients reperfused is similar across the 3 CCP of index admissions: 36.2% in A , 34.0% in B1 and 38.0 in CCP B2-B3, but the type of reperfusion differs (as expected): thrombolysis only in A and B1, half thrombolysis and half urgent PCI in CCP B2-B3. The overall rates of revascularization (during episode of care) do differ between the 3 CCP of index admissions. While patients first admitted to A and B1 have revascularization rates of 32.4% and 33.1% (not during their first stay but after a transfer to a B2-B3 hospital), the revascularization percentage in B2-B3 is 53.7%. Percentages of patients treated conservatively also differ across 3 CCP: 46.7% in A , 47.7% in B1 and37.5% in CCP B2-B3.

Table 5: Treatment during Episode of Care, and during Index Admission, per CCP of Index Admission

	Cardiac Care Program of Index Admission			
	A (%)	B1 (%)	B2-B3 (%)	All Patients (%)
Number of Index Admissions	15205	6367	13389	34961
During the Index Admission (First Stay)				
Conservative Therapy	60.5	62.6	41.3	53.5
Reperfusion	36.2	34.0	38.0	36.5
Thrombolysis	36.0	33.9	20.6	29.7
Urgent PCI	0.3	0.2	19.7	7.7
Urgent CABG	0.0	0.0	0.5	0.2
Revascularization	6.9	6.8	48.3	22.7
PCI	6.8	6.8	43.8	21.0
CABG	<0.1	0.0	4.9	1.9
CAG	9.4	18.0	55.2	28.5
Drug Treatment				
Beta-Blockers	63.7	63.9	68.2	65.5
GPIIbIIIa	2.1	1.5	19.0	8.5
During the Episode of Care				
Conservative Therapy	46.7	47.7	37.5	43.4
Revascularization during Episode	32.4	33.1	53.7	40.7
PCI	25.1	25.8	46.5	33.4
CABG	7.5	7.5	8.1	7.7
CAG	35.9	41.2	60.1	46.1
Drug Treatment				
Beta-Blockers	68.4	68.9	71.0	69.5
GPIIbIIIa	7.3	5.7	19.5	11.7

Transfers of Patients between Different Cardiac Care Program Hospitals

As described in Figure 12, 63.4% of the patients had a single stay episode of care, meaning that these patients stayed in only one hospital and were not readmitted or transferred to another hospital during the same month or the month following the index admission. This percentage differs greatly across CCP, because CCP A and B1 hospitals do not have the possibility to treat their patients invasively, and therefore transfer some of their patients to a B2-B3 hospital, where invasive treatment modalities are available.

Of the 15205 patients initially admitted to an A hospital, 52.7% had a single stay episode of care and 38.4 % had a second stay in a B2-B3 hospital. The rest of the patients (8.9%) were either readmitted to the first hospital or to a B1 hospital. Some of these patients (15.0%) who were first transferred to a B2-B3 hospital, "went back home", to their A hospital.

The same pattern is observed for B1 hospitals, with slightly more patients with a single stay episode of care (56.6% of patients) and slightly less patients transferred to a B2-B3 hospital (33.4%). The percentage of patients "going back home" is similar (15.0%).

For the B2-B3 hospitals, the story is different, as all treatment strategies are available on site, obviating the need for transfer of patients. A total of 78.8% of patients first admitted to a B2-B3 hospital had a single stay episode of care, another 13.6% were readmitted in a B2-B3 hospital, and 7.5% had a second stay in an A or a B1 hospital. The latter groups of patients with a B2-B3 / A or B2-B3 / B1 admission history might represent a specific subpopulation. We assume that many of them were in fact patients that were initially admitted to an A or a B1 hospital but were transferred very soon to the B2-B3 hospital, i.e. before the first admission night. Due to billing rules, patients that do not stay for at least one night in hospital are not considered as being admitted and hence, in this particular case, their index admission is considered as a B2-B3 admission. Many of the patients in this scenario might in fact be P-PCI cases or maybe patients in very bad condition requiring specific care (e.g. intra-aortic balloon pump, …..). We found that many more patients in this scenario underwent a PCI than the total population (cf.5.2.4).

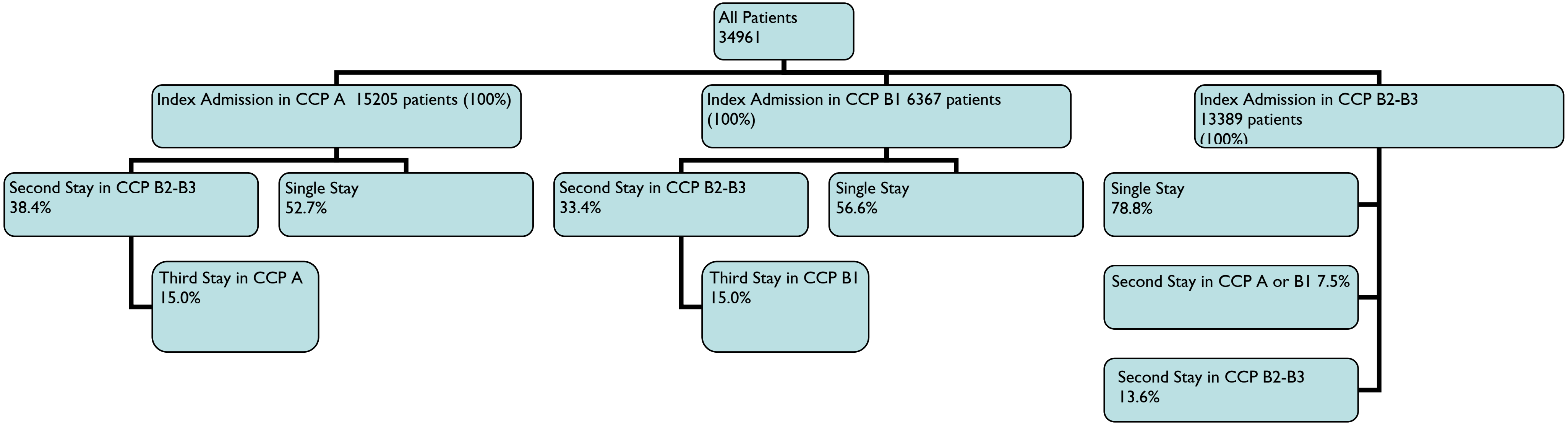


Figure 12 : Transfers of Patients Across Cardiac Care Program Hospitals

4.1.4. Overall costs of Acute Myocardial Infarction

The following section presents the overall costs for the whole Episode of Care for All Patients, globally and by CCP of index admission. Total costs can be divided in two parts: the first part is the "partial bill", i.e. the reimbursed amounts for all medical acts and supplies (drugs, implants, blood, …) and the other part is the all-in price paid per day (or "patient per day/per diem price").

The mean cost per patient per episode (global bill) was 8110 € (IQR 3810-10400 €). By index admission in secondary (A) hospitals, the mean cost was 7640 € (IQR 3290-10380). By index admission in intermediary (B1) hospitals, the mean cost was 7780 € (IQR 3800 – 10070). By index admission in tertiary (B2-B3) hospitals, the mean cost was 8800 € (IQR 4670 – 10 580).

The mean cost per day of stay was 215 € (index admission hospitals=A hospitals), 223 € (B1 hospitals) and 273 € (B2-B3 hospitals). This average price per day (per diem) was computed by dividing the total paid during the whole episode of care by the length of episode.

The mean cost per patient per episode of the partial bill (covering all billed costs of diagnostics and therapy) was, by index admission in a secondary (A) hospital, 4447 € (IQR 1320 - 6710). By index admission in intermediary (B1) hospitals, the mean cost was 4499 € (IQR 1680 – 6250). By index admission in tertiary (B2-B3) hospitals, the mean cost was 5221 € (IQR 1980 – 6870). The previous results can also be seen on Table 6 and Table 7.

Table 6 : Partial and Total bill of the whole Episode of Care, per CCP of index admission (All Patients)

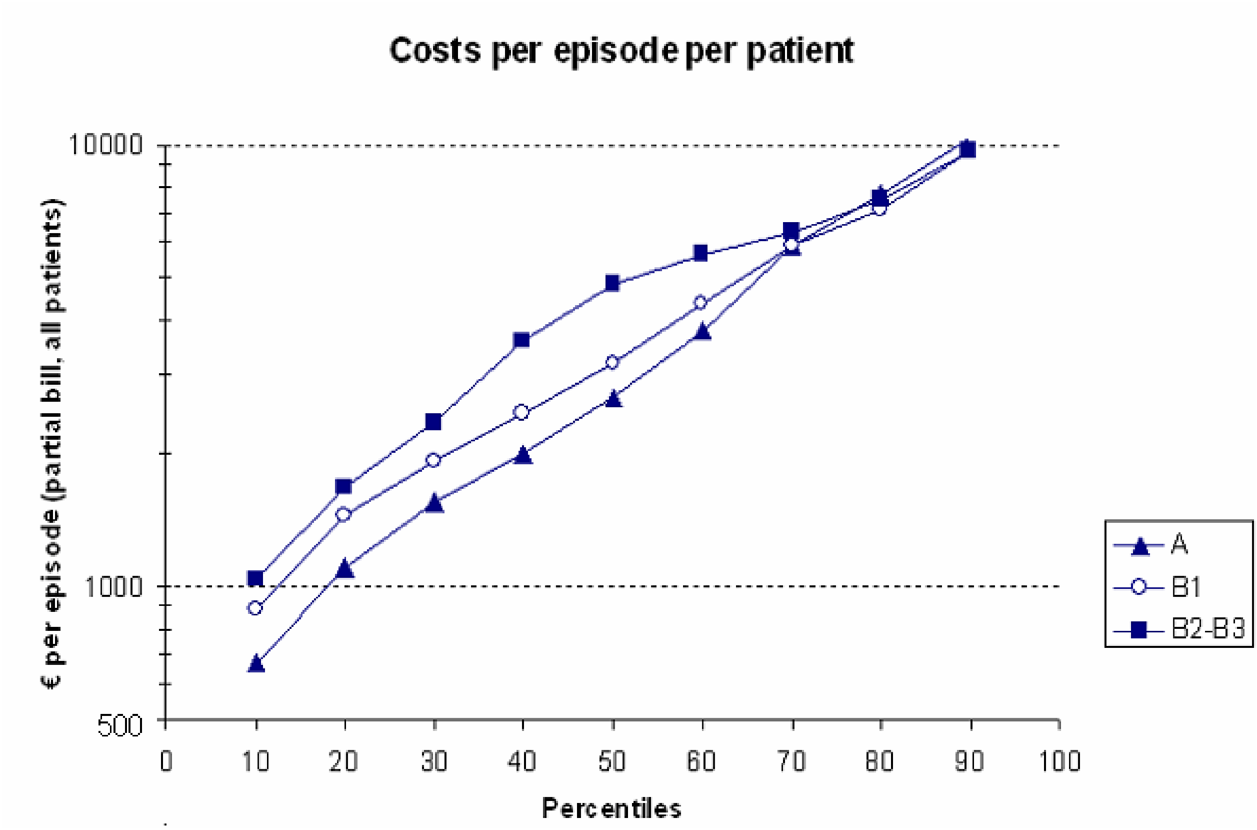
		Partial bill					Total bill				
CCP	N patients	Mean	Std dev	Median	Lower Quartile	Upper Quartile	Mean	Std dev	Median	Lower Quartile	Upper Quartile
A	15205	4447	4720	2661	1324	6712	7642	6793	5800	3287	10384
B1	6367	4499	3906	3170	1679	6521	7783	5960	6303	3799	10075
B2-B3	13389	5221	5001	4840	1980	6865	8802	7431	7447	4671	10579
All	34961	4753	4710	3474	1597	6741	8112	6927	6697	3815	10399

Table 7 : Average Price per day per CCP of index admission (All Patients).

CCP	N patients	Mean	Std dev	Median	Lower Quartile	Upper Quartile
A	15205	214.9	34.2	210.3	189.7	233.5
B1	6367	222.8	32.5	215.7	200.5	241.3
B2-B3	13389	272.3	55.1	261.5	224.1	314.4
All	34961	238.3	50.9	225.6	202.5	261.6
Note: this price was computed on whole episode (total amount paid per day divided by LOE)						

Figure 12bis shows the distribution on a log scale. The costs of the more expensive patients (percentiles > 70 %) is independent of their index-admission in A, B1 or B2-B3 hospitals. This suggests that there was no selective reference of the more expensive patients to the tertiary level (as hospital of index admission). At lower levels of costs, patients who start the disease episode in A hospitals are cheaper than those in B1, which are cheaper than in B2-B3, regardless of all later transfers. This suggests that at higher reference levels, more diagnostic and therapeutic interventions are offered to the patient, regardless of need: the demand is induced by the supply.

Figure 12bis: Cost per Episode per patient, per CCP of Index admission (All Patients).



4.2. VARIABILITY IN MANAGEMENT OF ACUTE MYOCARDIAL INFARCTION (LOW RISK GROUP)

4.2.1. Description of Population Selected

Of the 34961 patients that have been included in the study for first admission for AMI diagnosis, 13868 (39.7%) were younger than 75 years, had no cardiovascular history, no diabetes, had an index admission APR-DRG in the Major Diagnostic Category 5 (Diseases and Disorders of the Circulatory system) and were alive at the end of their episode. These patients form the "Low Risk Group", which is studied more extensively now. All analyses presented in this chapter, related to the study of the variability between CCP and hospitals in the management of Acute Myocardial Infarction, have been performed on this population, the Low Risk Group.

Baseline Demographics

Figure 13 shows the population pyramid of the 34961 AMI patients, including the distribution of the patients in the Low Risk Group (represented by the pale colours). By definition, no patient above or 75 years old are included in this population. More patients were relatively discarded from the Female patients in order to form this homogeneous population (75.5% were discarded from the Female population against 52.7% from the Male population; if we consider only patients aged below 75 year, the filtering amounts respectively 45.9% against 36.5%).

Of the patients 13868 patients included in the Low Risk Group, 79.2% were male. Mean age at first admission was 58.5 years (57.8 years for male and 61.4 years for female).

Figure 13 : Population Pyramid for All Patients and for the Low Risk Group.

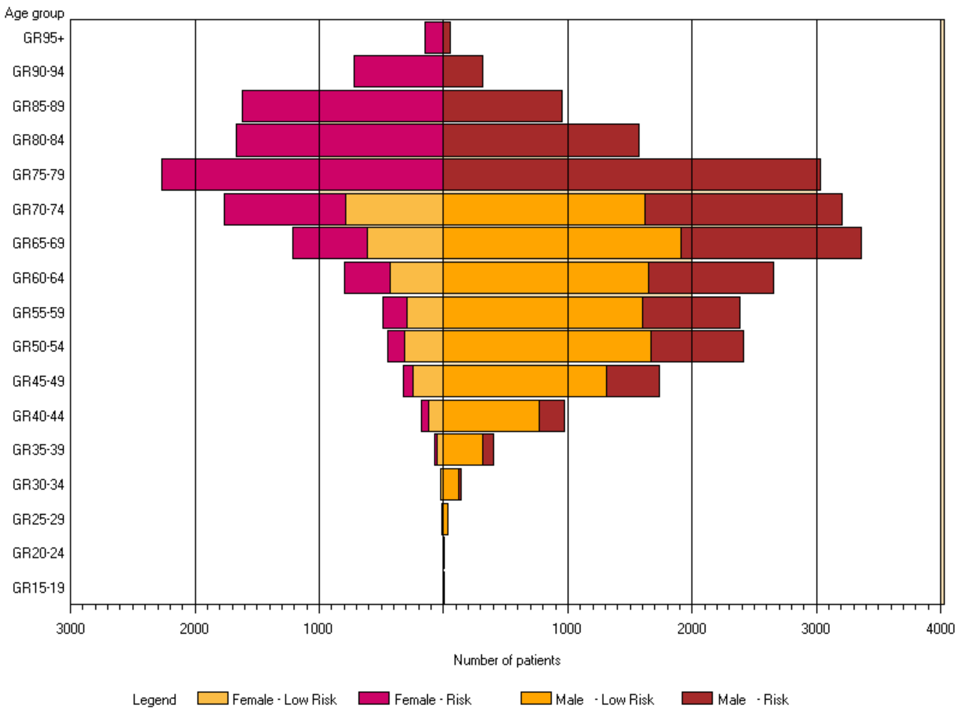


Table 8 presents baseline patients characteristics and outcomes for all patients included in the Low Risk Group, by CCP of index admission.

Table 8 : Baseline Demographics Characteristics by CCP of Index Admission (Low Risk Group)

	Cardiac Care Program of Index Admission			
category	A	B1	B2-B3	All Patients (Low Risk)
Total Index Admissions (Count)	5945	2452	5471	13868
Age Mean (SD)	59.3 (10.2)	58.1 (10.7)	57.9 (10.4)	58.5 (10.4)
Male Patients (%)	79.5	77.2	79.9	79.2
Number Sec Diagnoses Mean (SD)	3.0 (2.5)	4.7 (3.2)	4.6(3.4)	3.9 (3.1)
Sec Diagnoses > 4 (%)	22.1	42.9	43.0	34.0
Pump Failure (%)				
Heart Failure	10.2	10.6	10.2	10.3
Shock	4.0	3.6	6.5	4.9
Single Stay Episode Patients (%)	33.8	41.9	78.0	52.7
Single Hospital Patients (%)	37.1	48.7	91.9	60.8
APR-DRG (%)				
165 (CABG)	0.1	0.0	4.4	1.8
174 (PTCA with AMI)	2.2	1.6	53.1	22.2
190 (Circulatory disorders with AMI)	82.2	92.5	36.1	65.8
207 (Other circulatory disorders)	13.0	2.7	0.7	6.3
other	2.6	3.2	5.6	3.9
Death during Month 0/1 *	0.7	0.2	0.4	0.5
Death at Year 1	2.6	2.0	2.2	2.3
Death at Year 2	4.2	4.1	3.5	3.9

* Note: by definition, patients from the Low Risk Group are discharged alive at the end of their episode of care.

Treatment

Figure 14 presents the flowchart already presented in section 4.1.3, but for the patients included in the Low Risk Group.

Table 9 presents the different types of treatment received, by CCP of index admission. The reperfusion rate in the Low Risk Group is higher then in the All Patients group (Figure 8) (48% versus 36.5%), as well as for the thrombolysis percentage (38.9% versus 29.7%).

Figure 14: Description of Treatment during Index Admission and whole Episode of Care (Low Risk Group).

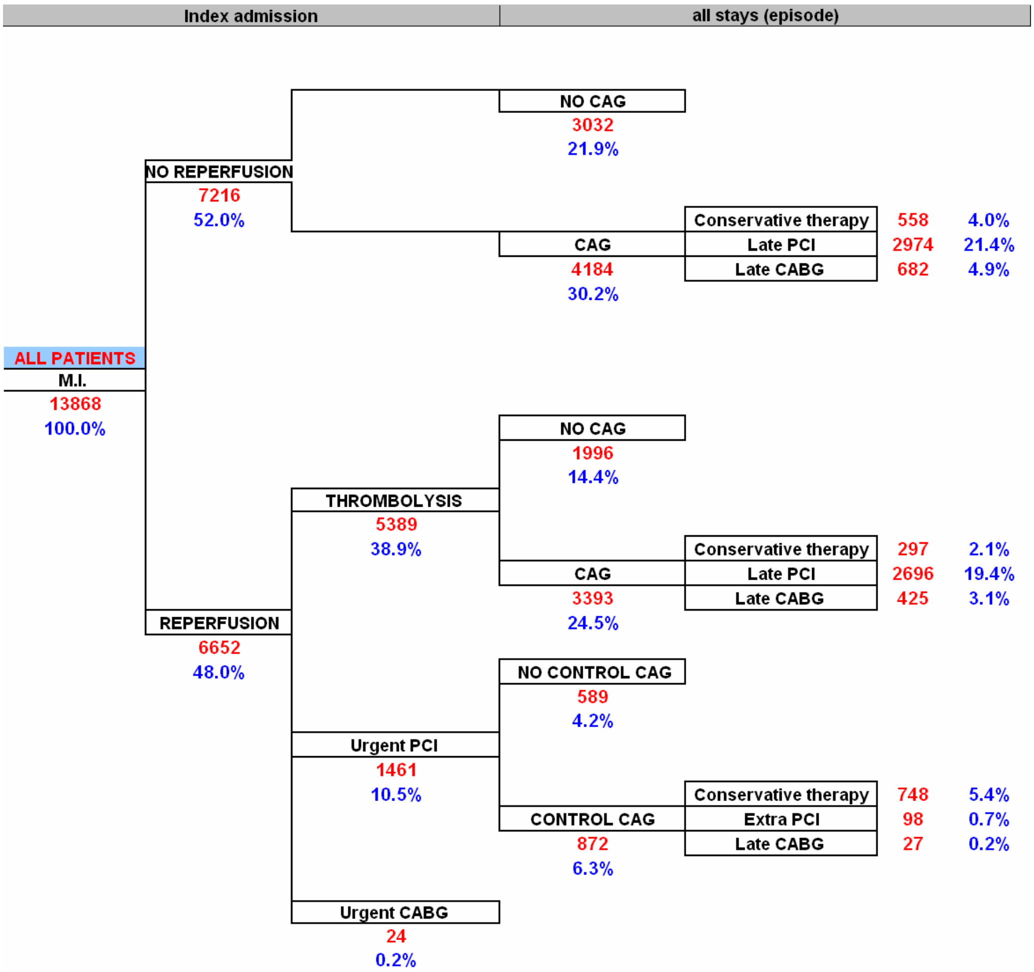


Table 9 : Treatments during Index Admission and Episode of Care, per CCP of Index Admission (Low Risk Group)

	Cardiac Care Program of Index Admission			
	A (%)	B1 (%)	B2-B3 (%)	All Patients (Low Risk)
Number of Index Admissions	5945	2452	5471	13868
During Index Admission (First Stay)				
Conservative Therapy	47.1	49.2	26.0	39.2
Reperfusion	47.7	46.0	49.1	48.0
Thrombolysis	47.4	46.0	26.4	38.9
PCI urgent	0.5	0.2	26.1	10.5
CABG urgent	0.0	0.0	0.4	0.2
Revascularization	11.4	9.5	63.0	31.4
PCI	11.4	9.5	59.0	29.8
CABG	<0.1	0.0	4.5	1.8
CAG	14.8	23.5	69.9	38.1
Drug Treatment				
Beta-Blockers	75.4	75.0	78.9	76.7
GPIIbIIIa	3.4	2.0	25.1	11.7
During Episode of Care				
Conservative Therapy	27.8	30.2	21.6	25.8
Revascularization during Episode	50.0	48.0	70.2	57.6
PCI	41.7	39.8	63.2	49.9
CABG	8.6	8.3	7.9	8.3
CAG	54.5	57.2	76.7	63.7
Drug Treatment				
Beta-Blockers	81.4	81.6	82.0	81.7
GPIIbIIIa	11.9	8.9	26.0	16.9

Transfers across Cardiac Care Program Hospitals

The number and destination of patients transferred between hospitals from a CCP to hospitals from another CCP are obviously very different between A/B1 and B2-B3 hospitals. Figure 15 presents the percentage of patients with a single stay episode, readmitted for their second stay to a hospital belonging to the same CCP (not necessarily the index admission hospital) or transferred for their second stay to a hospital from another CCP. For simplicity, only transfers or readmissions during the second stay of the episode of care are taken into account.

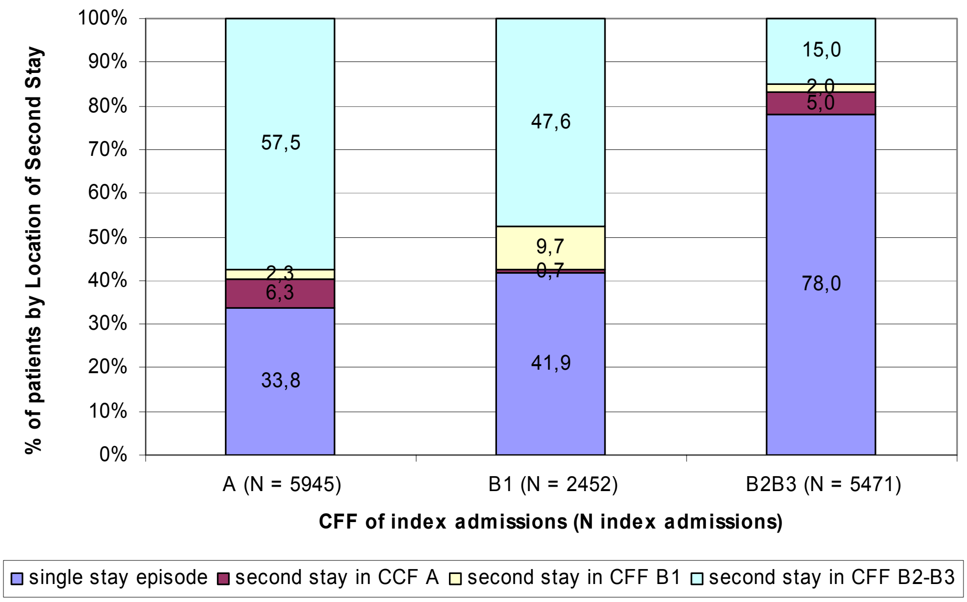
Figure 15 shows that

- For the 5945 patients with index admission in a A hospital: 33.8% of these have a single stay episode and 57.5% are transferred to a B2-B3 hospital (in second stay)
- For the 2452 patients with index admission in a B1 hospital: 41.9% of these patients have a single stay episode and 47.6% are transferred to a B2-B3 hospital (second stay)
- For the 5471 patients with index admission in a B2-B3 hospital: 78% of these patients have a single stay episode and 7% are transferred to A or B1 hospital (second stay)

Table 10 : Counts of patients by CCP of First and Second Stay (Low Risk Group)

	Index Admission in					
	CCP A		CCP B1		CCP B2-B3	
	N	%	N	%	N	%
Index Admission	5945	100%	2452	100%	5471	100%
Single stay episode	2011	33.8	1028	41.9	4270	78.0
Second Stay in CCP A	375	6.3	18	0.7	273	5.0
Second Stay in CCP B1	139	2.3	238	9.7	108	2.0
Second Stay in CCP B2B3	3420	57.5	1168	47.6	820	15.0

Figure 15: Counts of patients by CCP of First and Second Stay (Low Risk Group)

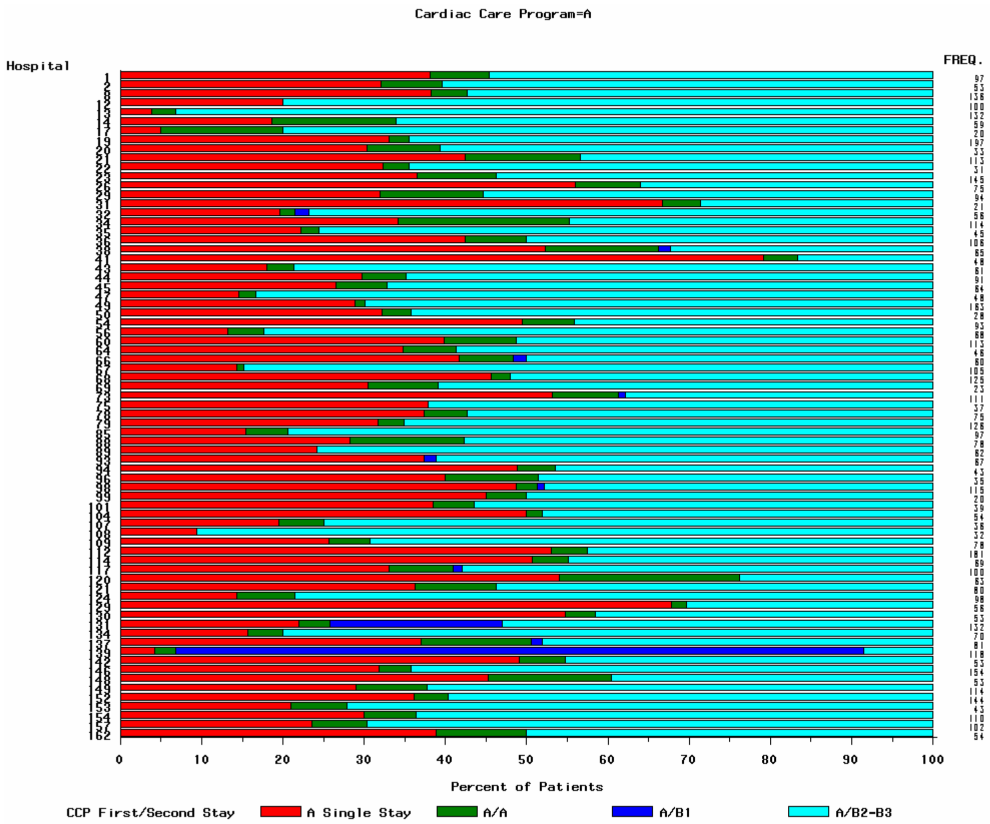


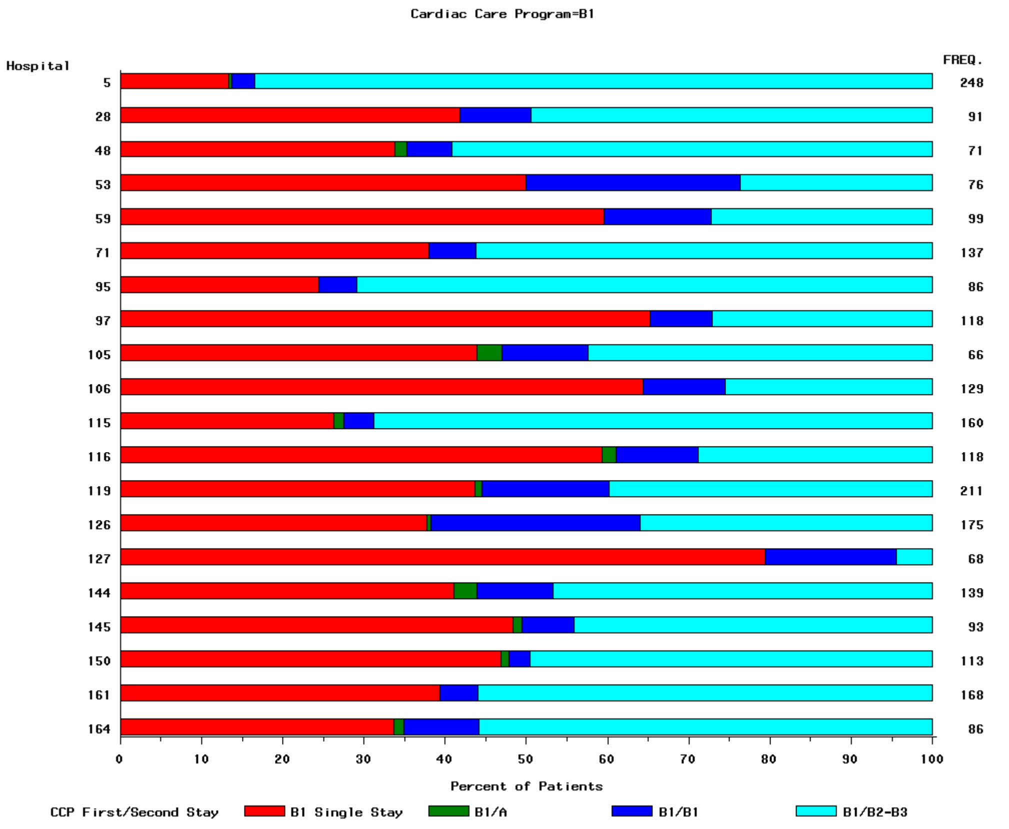
4.2.2. Variability in Transfers of Patients

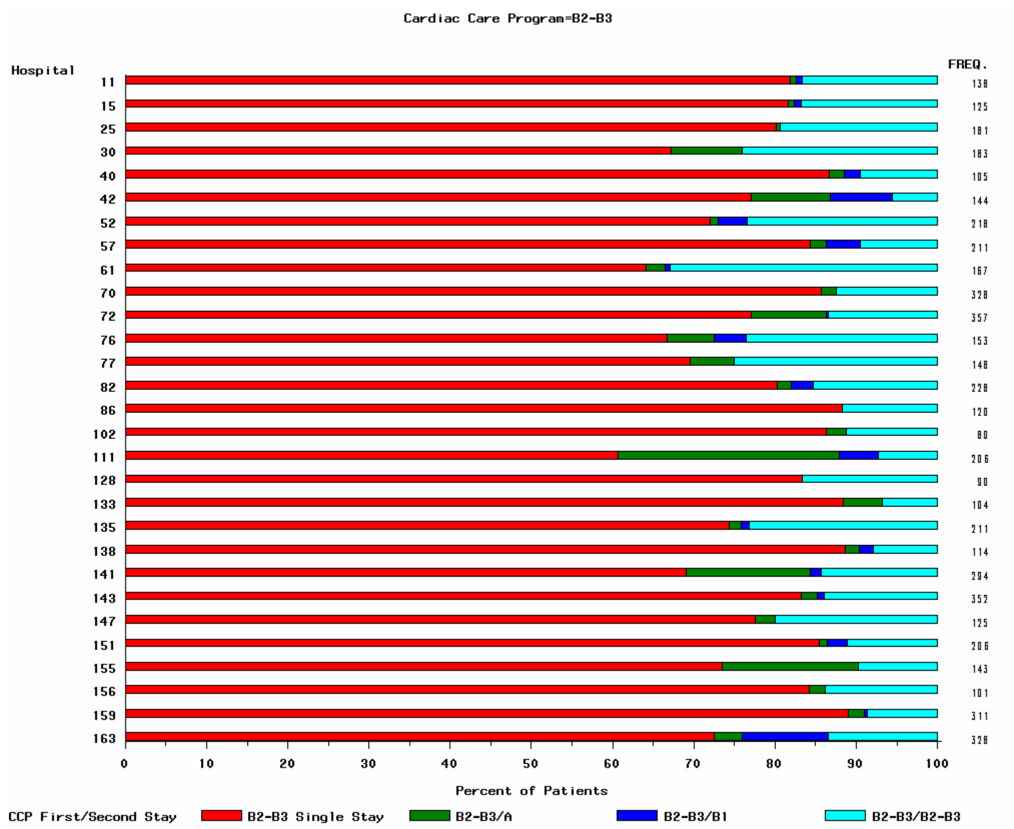
To assess the variability in percentage of patients transferred or readmitted to a hospital from another CCP, Figure 16 presents, for each hospital of the index admission, the number of patients with a single stay episode, the number of patients readmitted in a hospital of the same CCP, and the number of patients transferred to a hospital from another CCP. The total counts are based on the number of index admissions per hospital.

While the majority of the A and B1 hospitals tends to send roughly half of their patients to a B2-B3 hospital, some hospitals have a different pattern (almost all or very few patients sent to B2-B3, or patients from CCP A sent to CCP B1). In B2-B3 hospitals, the variability between hospitals is smaller, as the majority (78%) of the patients has a single stay episode (no transfer or readmission).

Figure 16 : Destination of Second Stay (CCP) of Patients by CCP of First Stay (Index Admission) (Low Risk Group)

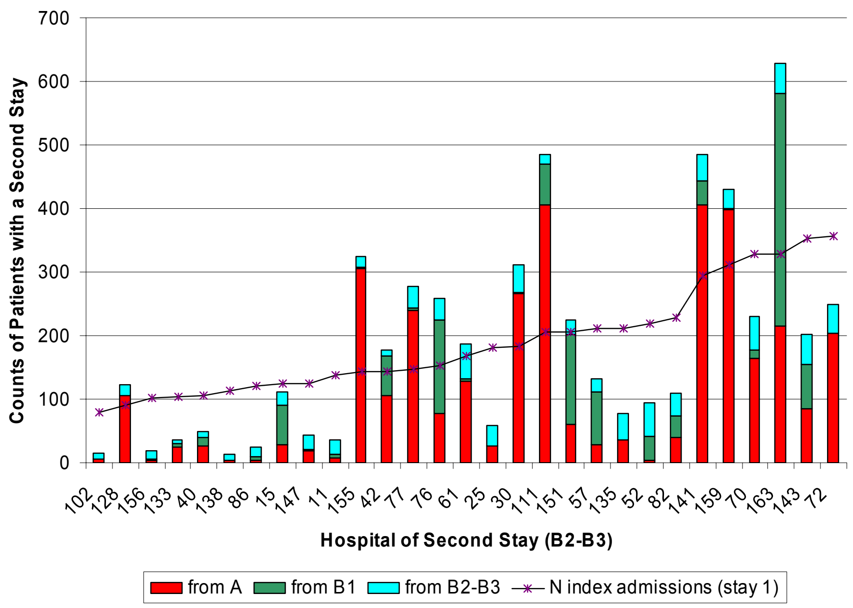






In order to explore whether some of the B2-B3 hospitals receive more patients from A-B1 hospitals than others, Figure 17 presents the counts of patients having a second stay in a B2-B3 hospital (either because a readmission from a B2-B3 hospital, either because a transfer from A or B1 hospital), by hospital. There is an enormous difference between hospitals, ranging from a few patients transferred from A/B1 hospitals to approximately 600 for the largest hospital. To give a point of comparison, index admissions (first stays) in the B2-B3 hospital are also displayed on the graphic, and show that there is no relationship between the number of index admissions and the number of patients transferred into the hospital.

Figure 17: Counts of Patients with a Second Stay in CCP B2-B3 Hospital, by CCP of First Stay (Low Risk Group)



4.2.3. Variability in Diagnostics

Diagnostic Tests

Table 11 gives descriptive statistics on the number of diagnostic tests in the 13868 patients of the Low Risk Group, during their global episode of care, as well as during their index admission. This table reads as follows: 12.6% of the patients had at least one angiocardiography performed during their episode of care (8.8% performed during the index admission). On average, 0.13 angiocardiography per patient were performed during the episode of care (0.09 during the index admission).

Table 11 : Percentage of Patients and Average Number of Diagnostic Tests per Patient (Low Risk Group)

	During Episode of Care				During Index admission			
Diagnostic Test	% of patients	Mean	p10	p90	% of patients	mean	p10	p90
AMBULATORY 24-HOUR-ECG MONITORING	35.7%	0.37	0	1	30.5%	0.31	0	1
AMBULATORY 24-HOUR-ECG MONITORING WITHOUT FULL-DISCLOSURE	9.3%	0.23	0	0	7.5%	0.18	0	0
ANGIOCARDIOGRAPHY	12.6%	0.13	0	1	8.8%	0.09	0	0
AORTOGRAM	8.8%	0.09	0	0	6.4%	0.06	0	0
CARDIAC RADIONUCLIDE IMAGING	34.5%	0.56	0	2	30.6%	0.49	0	2
CAROTID DUPLEX ULTRASOUND	20.0%	0.21	0	1	16.1%	0.16	0	1
CHEST X-RAY	94.2%	3.51	1	7	92.3%	2.71	1	5
CORONARY ANGIOGRAPHY	57.8%	0.98	0	2	37.0%	0.56	0	2
ECG-MONITORING	80.1%	2.57	0	5	77.1%	2.08	0	3
ECG-MONITORING, COMBINED WITH INVASIVE MONITORING OF BLOOD PRESSURE A/O CENTRAL VENOUS PRESSURE	33.0%	1.06	0	4	24.7%	0.7	0	3
ECHOCARDIOGRAPHY	78.6%	1.1	0	2	73.1%	0.92	0	2
ELECTROPHYSIOLOGICAL STUDY (EPS)	0.0%	0.01	0	0	0.0%	0.00	0	0
ERGOSPIROMETRY	7.0%	0.07	0	0	6.0%	0.06	0	0
EXERCISE TESTING	36.8%	0.4	0	1	31.4%	0.33	0	1
INVASIVE HEMODYNAMIC MONITORING (SWAN-GANZ)	6.8%	0.07	0	0	3.6%	0.04	0	0
PHARMACODYNAMIC ECG TESTING	19.4%	0.31	0	1	16.0%	0.24	0	1
PULMONARY DIFFUSION CAPACITY	21.1%	0.23	0	1	17.7%	0.18	0	1
RESIDUAL LUNG VOLUME	22.2%	0.24	0	1	18.6%	0.19	0	1
RESPIRATORY MINUTE VOLUME	17.1%	0.19	0	1	14.3%	0.15	0	1
REST ECG	92.5%	4.23	1	8	84.0%	3.08	0	7
STUDY OF VENTILATION MECHANICS	17.1%	0.19	0	1	14.0%	0.15	0	1
TRANSOESOPHAGEAL ECHOCARDIOGRAPHY (TEE)	4.5%	0.05	0	0	2.1%	0.02	0	0
VECTORCARDIOGRAM	24.5%	0.59	0	2	20.3%	0.45	0	1

As some diagnostic tests are performed very frequently, summary statistics per day instead of per stay or per episode have been computed. Table 12 presents the parameters for monitoring, ECG and X-ray per day per patient (across the whole episode and during the index admission). The intensity of diagnostic use per day seems higher at the index admission than if we consider the whole episode. A mean = 0.33 equals one diagnostic every 3 days.

Table 12: Percent of Patients and Average Number of Diagnostic Tests per Day and per Patient (Low Risk Group)

	During Episode of Care				During Index admission			
Diagnostic test	% of Patients	mean	P10	P90	% of Patients	mean	P10	P90
CHEST X-RAY	94.2%	0.31	0	1	92.3%	0.37	0	1
ECG-MONITORING, COMBINED WITH INVASIVE MONITORING OF BLOOD PRESSURE A/O CENTRAL VENOUS PRESSURE	33.0%	0.09	0	0	24.7%	0.11	0	0
ECG-MONITORING	80.1%	0.28	0	1	77.1%	0.35	0	1
REST ECG	92.5%	0.37	0	1	84.0%	0.35	0	1

Table 13 : Diagnostic Tests and Clinical Utility (Low Risk Group)

Number of diagnostics during Index admissions / per CCF		All CCF					A (5945 patients)					B1 (2452 patients)					B2-B3 (5471)				
Diagnostic test	Clinical Utility†	Total N	%Hosp	%Pat	mean	index of use	N♥	%Hosp ♠	%Pat ♣	mean ♦	relative use‡	N ♥	%Hosp ♠	%Pat ♣	mean ♦	relative use‡	N ♥	%Hosp ♠	%Pat ♣	mean ♦	relative use‡
rest ECG	0	42697	99.2%	84.0%	3.66	3.06	17444	98.8%	83.3%	3.52	0.95	8388	100.0%	84.3%	4.06	1.12	16865	100.0%	84.7%	3.64	1.01
CHEST X-RAY	0	37523	100.0%	92.3%	2.93	2.71	14911	100.0%	95.5%	2.63	0.93	6928	100.0%	90.4%	3.12	1.04	15684	100.0%	89.7%	3.20	1.06
ECG-MONITORING	0	28862	98.5%	77.1%	2.70	2.05	14116	97.6%	84.0%	2.83	1.13	5126	100.0%	76.9%	2.72	1.02	9620	100.0%	69.8%	2.52	0.86
ECHOCARDIOGRAPHY	0	12712	100.0%	73.1%	1.25	0.92	4765	100.0%	66.9%	1.20	0.87	2629	100.0%	80.6%	1.33	1.17	5318	100.0%	76.4%	1.27	1.06
ECG-MONIT, INVASIVE MONIT OF BP A/O CVP	2	9772	92.5%	25.4%	2.86	0.67	2425	88.1%	14.6%	3.00	0.57	1889	100.0%	24.3%	3.17	1.15	5458	100.0%	36.9%	2.70	1.49
CORONARY ANGIOGRAPHY	1	7702	94.0%	37.2%	1.50	0.52	1180	90.5%	14.9%	1.35	0.35	654	100.0%	23.5%	1.14	0.51	5868	100.0%	67.3%	1.59	2.05
CARDIAC RADIONUCLIDE IMAGING	2	6757	91.7%	31.7%	1.59	0.46	2842	86.9%	31.7%	1.64	0.98	1316	100.0%	33.2%	1.61	1.16	2599	100.0%	31.0%	1.53	1.02
VECTORCARDIOGRAM	3	6179	73.7%	25.4%	2.19	0.41	1445	67.9%	23.4%	1.50	0.58	2300	85.0%	34.8%	3.10	2.24	2434	82.8%	22.9%	2.19	1.01
EXERCISE TESTING	0	4582	96.2%	31.5%	1.05	0.32	1924	94.0%	30.8%	1.06	0.96	818	100.0%	31.2%	1.07	1.04	1840	100.0%	32.4%	1.04	1.05
AMBULATORY 24-HOUR-ECG MONITORING	2	4293	88.0%	33.0%	1.02	0.29	1342	83.3%	25.7%	1.01	0.73	975	95.0%	42.1%	1.01	1.37	1976	96.6%	36.2%	1.02	1.21
PHARMACODYNAMIC ECG TESTING	3	3391	74.4%	18.8%	1.53	0.21	773	63.1%	13.8%	1.29	0.53	1263	85.0%	33.4%	1.91	2.53	1355	100.0%	17.5%	1.42	1.16
RESIDUAL LUNG VOLUME	3	2642	94.0%	18.8%	1.02	0.18	1339	90.5%	22.5%	1.03	1.15	583	100.0%	23.7%	1.01	1.31	720	100.0%	12.8%	1.03	0.73
PULMONARY DIFFUSION CAPACITY	3	2518	94.0%	17.9%	1.02	0.17	1213	90.5%	20.5%	1.02	1.10	579	100.0%	23.5%	1.01	1.37	726	100.0%	12.6%	1.05	0.77
AMBUL 24-H-ECG MONIT (no full disclosure)	3	2465	30.8%	24.2%	2.37	0.18	1333	34.5%	24.4%	2.28	1.09	159	20.0%	26.7%	1.67	0.51	973	27.6%	23.1%	2.71	0.98
CAROTID DUPLEX ULTRASOUND	2	2281	88.0%	16.6%	1.02	0.15	943	82.1%	16.5%	1.02	0.93	513	95.0%	21.3%	1.01	1.37	825	100.0%	14.8%	1.02	1.01
RESPIRATORY MINUTE VOLUME	3	2053	78.2%	16.3%	1.04	0.13	1082	67.9%	22.9%	1.04	1.22	387	100.0%	15.8%	1.00	1.19	584	93.1%	10.7%	1.06	0.80
STUDY OF VENTILATION MECHANICS	3	2015	83.5%	15.5%	1.04	0.13	796	75.0%	16.1%	1.03	0.93	505	100.0%	20.2%	1.02	1.53	714	96.6%	12.8%	1.06	0.97
ANGIOCARDIOGRAPHY	1	1248	63.2%	11.6%	1.02	0.07	223	51.2%	6.2%	1.00	0.43	317	80.0%	15.8%	1.00	1.69	708	86.2%	13.8%	1.03	1.64
AORTOGRAM	3	899	58.6%	8.6%	1.01	0.05	213	40.5%	6.8%	1.01	0.54	341	85.0%	15.2%	1.01	2.55	345	93.1%	6.9%	1.01	1.26
ERGOSPIROMETRY	2	845	33.1%	13.6%	1.02	0.05	363	31.0%	15.4%	1.03	1.07	10	20.0%	1.5%	1.00	0.07	472	48.3%	14.9%	1.02	1.58

Number of diagnostics during Index admissions / per CCF		All CCF					A (5945 patients)					B1 (2452 patients)					B2-B3 (5471)				
Diagnostic test	Clinical Utility†	Total N	%Hosp	%Pat	mean	index of use	N♥	%Hosp ♠	%Pat ♣	mean ♦	relative use‡	N ♥	%Hosp ♠	%Pat ♣	mean ♦	relative use‡	N ♥	%Hosp ♠	%Pat ♣	mean ♦	relative use‡
INVASIVE HEMODYN MONITOR (SWAN-GANZ)	3	552	66.2%	4.4%	1.10	0.03	91	47.6%	2.4%	1.10	0.38	76	95.0%	2.8%	1.13	0.95	385	100.0%	6.4%	1.10	2.18
TRANSOESOPHAGEAL ECHOCG (TEE)	3	313	65.4%	2.6%	1.07	0.02	73	50.0%	2.1%	1.00	0.57	48	85.0%	2.1%	1.02	0.99	192	96.6%	3.2%	1.12	1.86
ELECTROPHYSIOLOGICAL STUDY (EPS)	2	56	21.1%	1.1%	1.08	0.00	8	6.0%	2.4%	1.33	0.76	6	25.0%	0.9%	1.00	0.90	42	62.1%	1.1%	1.05	2.75
# WEIGHTED AVERAGE											0.95					1.25					1.14
## WEIGHTED FOR CLINICAL UTILITY											0.87					1.68					1.27

The use of diagnostic techniques varies from one Cardiac Care Program to another. In order to estimate this variability, Table 13 shows, per CCP, the percentage of hospitals that have used at least one of these techniques during the index admissions in the Low Risk Group. The percentage of index admissions of these hospitals that have received a diagnostic procedure is also given with the average number of diagnostic tests received by these patients. N=number of diagnostics. The tests are ranked by the total number applied. † Relevance according to guidelines and was judged on a scale from 0 till 3. 0 is considered highly useful, also in low risk patients, and does not add weight to the consumption index. 3 is considered of poor utility and is rarely, if ever, indicated. 1 means that the test is often useful, and often indicated but not as a matter of routine. 2 means that the test is not so useful, and rarely indicated. Absolute number of diagnostic tests (only Low Risk patients). ♠ % of hospitals that performed at least one intervention during index admission. ♣ % of patients tested in hospitals that performed at least one intervention. ♦ mean of tests per patient per admission. ‡ Relative use: product of columns ♠, ♣ and ♦ for that CCP divided by the same national product.

‡ = (x x) / Ntotal. If Relative use > 1.00, consumption is higher than average.
# Weighted average=Relative use of interventions weighted by the absolute number N of interventions applied in that CCP.
Weighted average for clinical utility = Relative use of interventions weighted by the absolute number and by clinical utility.

Table 13 summarizes use of diagnostic technology by Cardiac Care Program, diagnostic test and clinical relevance. The clinical relevance was defined as ranging between zero (highly useful in a low risk group, use advised in guidelines) and 3 (little or no clinical use in patients at low risk). 1 means that the test is not always indicated in all cases, 2 that the test may be indicated, but more rarely.

Use is identified by 'k' hospitals performing 'j' tests among 'i' patients. The table summarizes these data in simple indexes: the % of hospitals in that CCP that ever performed a test, the % of patients that ever received a test in these hospital performing at least one test and the mean of tests per patient. If many hospitals do many tests among many patients, use of that test is high. The national average is defined as the product of the percentages of hospitals, patients and the mean number of test per patient. The relative use in that care facility is defined as the same product specific to the care facility divided by the national average. In bold are indicated the care facilities that consumed relatively most. To summarize all use of diagnostic technology we created weighted averages. The first weighted average weighs the relative use of each technology for the absolute number of times it was performed. Tests that are performed rarely will add little weight to the average. The second weighted average weighs the relative use by the absolute number and the clinical utility. Highly relevant tests add zero weight.

Cardiac Care Programs B1 hospitals are obviously high consumers and high consumers of less useful technology. CCP B1 hospitals consume 25% more than average, and 68% less useful technology. It remains clinically unexplained why these consumption indices of B1 are so much higher than A. It is to be noted that B1 cannot do interventions and that all patients are considered at low risk. While lower levels might be explained in A-CCP (as a large number will be referred to B2-B3 facilities), the increased use in B2-B3 facilities is still rather moderate (14%).

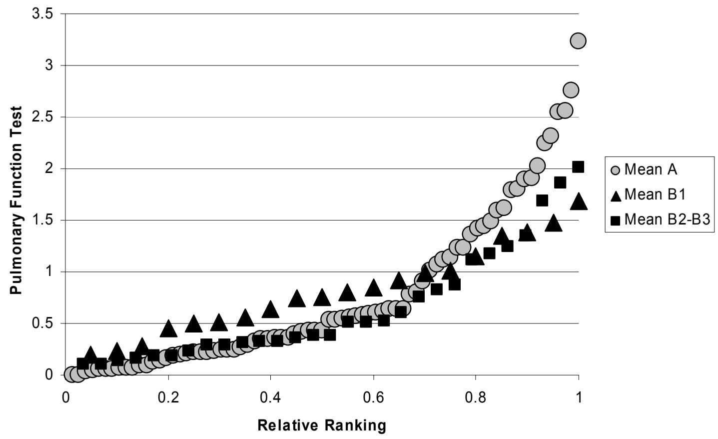
As the tests are ranked by absolute use, we find high up in the list more relevant tests with high numbers. These add to the weighted average, but not to the weighted average of irrelevant testing. Cardionuclide imaging does not add a lot to the difference between Care Programs either, as the differences between CCP are modest. The first test that penalises differentially overuse is vectorcardiography. This obsolete test without clinical indication that has never found any place in any known guideline was used more than 6000 times during the study period, or 2.2 times in 25% of the patients in 74% of the hospitals. In B 1 facilities, this test was used 3.1 times in 35% of the patients of 85% of the hospitals.

The following figures show the distribution per hospital of the average number of diagnostics received by a patient during his index admission. Four groups of diagnostics were built by adding the number of different diagnostics together:

- Pulmonary function test (=Respiratory minute volume + Residual lung volume + Pulmonary diffusion capacity + Study of ventilation mechanics + Ergospirometry)
- Electrocardiography tests (=all ECG monitorings combined or not with invasive monitoring of blood pressure, and ambulatory or no + Rest ECG + Vectorcardiogram)
- Invasive diagnostic tests (=CAG + Angiocardiography + Aortogram + Invasive hemodynamic monitoring)
- Non-invasive diagnostics (left ventricular function study) (=Echocardiography + Cardiac Radionuclide Imaging).

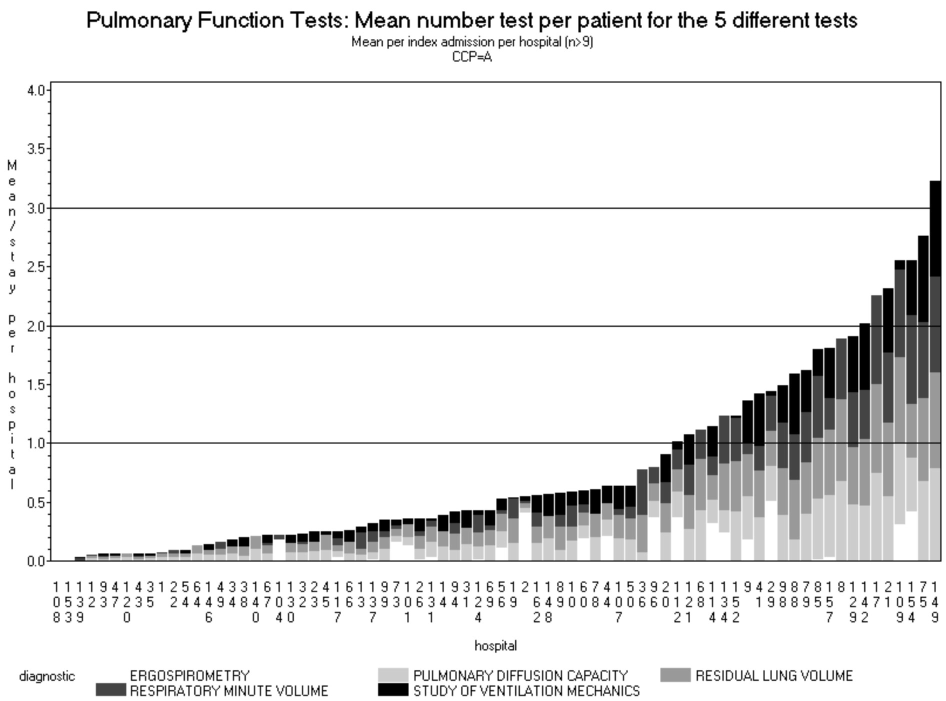
The relative ranking shows the place in the hierarchy: in 20 B1 hospitals, the lowest consumer gets rank 1/20, in 29 B2 1/29, in 76 A 1/76. The second lowest B1 gets 2/20, the second B2 2/29, the second A 2/76, etc.

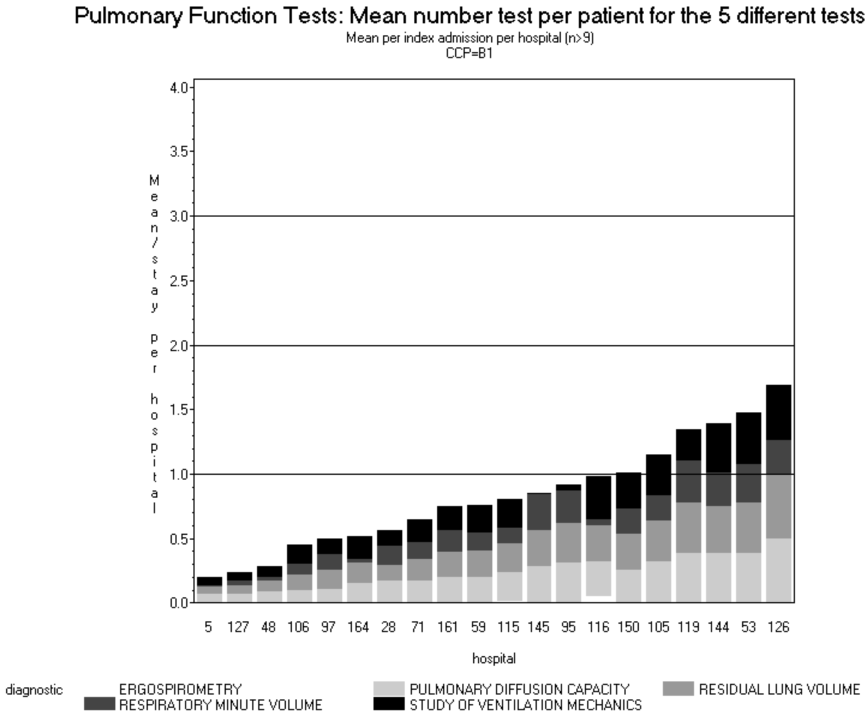
Figure 18: Pulmonary Function: Average Number per Index Admission per Hospital (Low Risk Group).



For the Pulmonary function, Figure 19 gives the mean per each of the five test per hospital. Hospitals that use pulmonary function, seem to use four (or even five when ergospirometry is used) types of tests. Ergospirometry is almost not used in B1 hospitals.

Figure 19: Pulmonary Function: Average Number per test per Index Admission per Hospital (Low Risk Group).




Pulmonary Function Tests: Mean number test per patient for the 5 different tests
Mean per index admission per hospital (n>9)
CCP=B1
Mean/stay per hospital
hospital
5 127 48 106 97 164 28 71 161 59 115 145 95 116 150 105 119 144 53 126
diagnostic
ERGOSPIROMETRY
PULMONARY DIFFUSION CAPACITY
RESIDUAL LUNG VOLUME
RESPIRATORY MINUTE VOLUME
STUDY OF VENTILATION MECHANICS

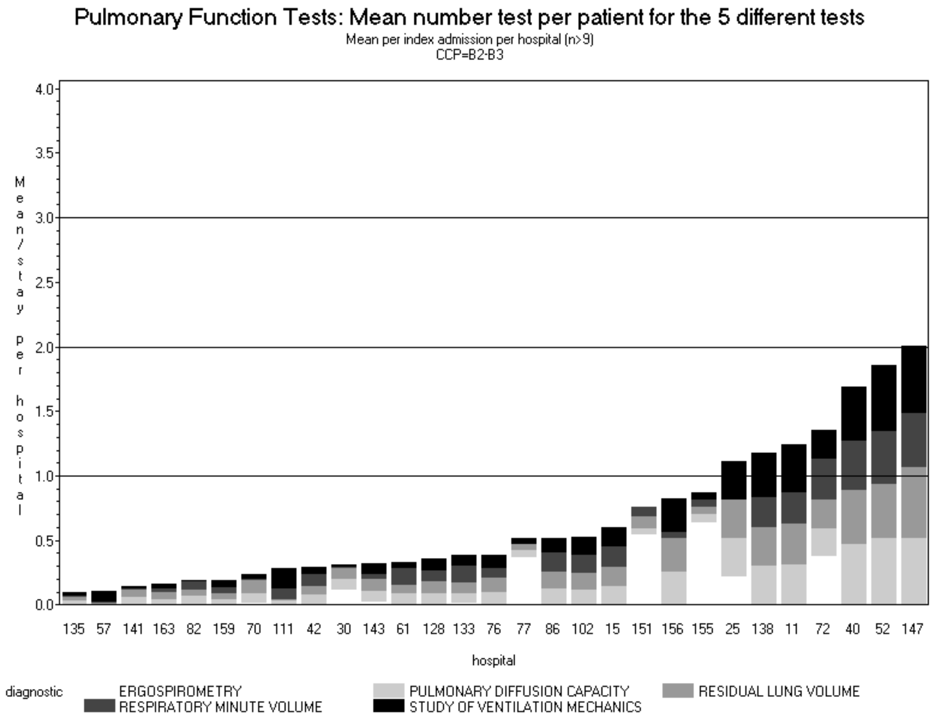

Pulmonary Function Tests: Mean number test per patient for the 5 different tests
Mean per index admission per hospital (n>9)
CCP=B2-B3
Mean/stay per hospital
hospital
135 57 141 163 82 159 70 111 42 30 143 61 128 133 76 77 86 102 15 151 156 155 25 138 11 72 40 52 147
diagnostic
ERGOSPIROMETRY
PULMONARY DIFFUSION CAPACITY
RESIDUAL LUNG VOLUME
RESPIRATORY MINUTE VOLUME
STUDY OF VENTILATION MECHANICS

Figure 20: Electrocardiography: Average Number per Index Admission per Hospital (Low Risk Group).

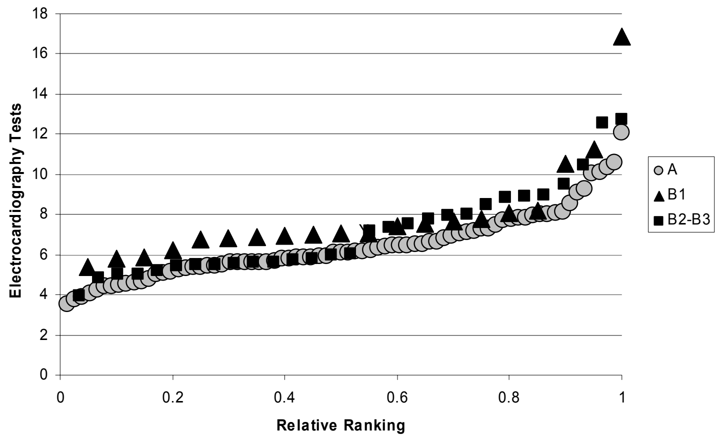


Figure 21 : Invasive Diagnostics: Average Number per Index Admission per Hospital (Low Risk Group).

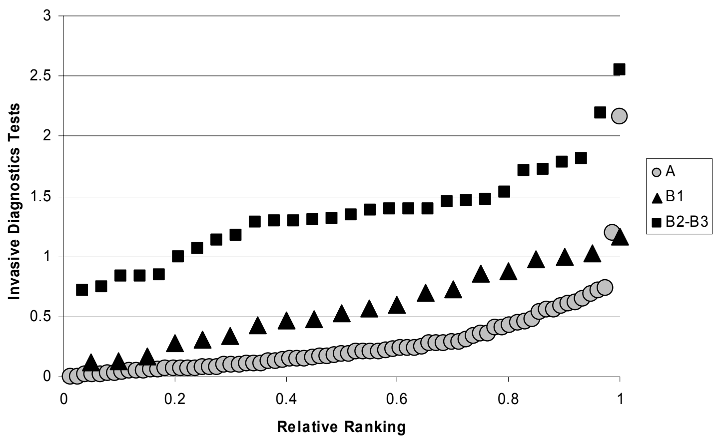
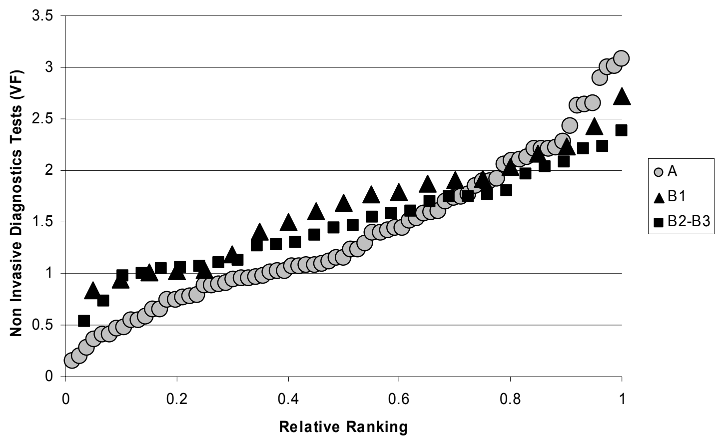


Figure 22 : Non-invasive diagnostics (Left Ventricular function study): Average Number per Index Admission per Hospital (Low Risk Group)



Electrophysiological study (EPS)

This diagnostic technique remains marginally used in Belgium in the early phase following AMI, in 1999, 2000 and 2001. On the 23376 stays of the Low Risk Group, 119 stays only underwent an electrophysiological study with one of the two possible codes invoiced. There are 2 possible billing codes to invoice such a technique: one for the complete study (476280, see also Appendix C1) and one for a more restricted study (476302) which was invoiced during 12 stays only. It should be stressed though that a few hospitals use the complete technique in a small percentage of their stays, the highest percentage observed being 4.3%.

Consumption index

The following diagnostic techniques were taken into account for the Consumption Index:

- Ambulatory 24-hour-ECG Monitoring (full disclosure)
- Carotid duplex ultrasound
- Invasive hemodynamic monitoring (Swan-Ganz)
- Pharmacodynamic ECG testing
- Pulmonary diffusion capacity
- Residual lung volume
- Respiratory minute volume
- Study of ventilation mechanics
- Transoesophageal echocardiography (TEE)
- Vectorcardiogram

Consumption index calculated on all episodes (Low Risk Group)

See Appendix E2.

Consumption index calculated on single stay episodes only.

Considering all the 7309 single stays episodes of the 13868 patients in the Low Risk Group, Table 14 shows the global results of the mean consumption index per hospital (with minimum 10 stays) as well as a differentiated result per Cardiac Care Program. Levels of use of diagnostic technology not advocated in guidelines, with uncertain clinical significance and not established cost-effectiveness was rather high. In A hospitals, a mean of 1.7 interventions per patients was performed, in B2 hospitals 2.0 and in B1 hospitals 3.2. In B1 hospital, the variance was larger, too, showing high variability in resource consumption. In the components of the Consumption Index, vectorcardiography and pharmacodynamic ECG-testing in particular show differences between CCP; the average number of vectorcardiography per single stay episodes was 0.25 in A (median: 0.04; Q1: 0.00; Q3:0.31), 1.06 in B1 (median: 0.64 Q1: 0.09; Q3:1.57) and 0.57 in B2-B3 (median: 0.16 Q1: 0.02 ; Q3:0.58); the average of pharmacodynamic ECG testing was 0.13 in A hospitals (median: 0.06; Q1:0.00; Q3:0.23), 0.55 in B hospitals (median: 0.24; Q1:0.05; Q3:0.72) and 0.22 in B2-B3 hospitals (median:0.07; Q1:0.02; Q3:0.20).

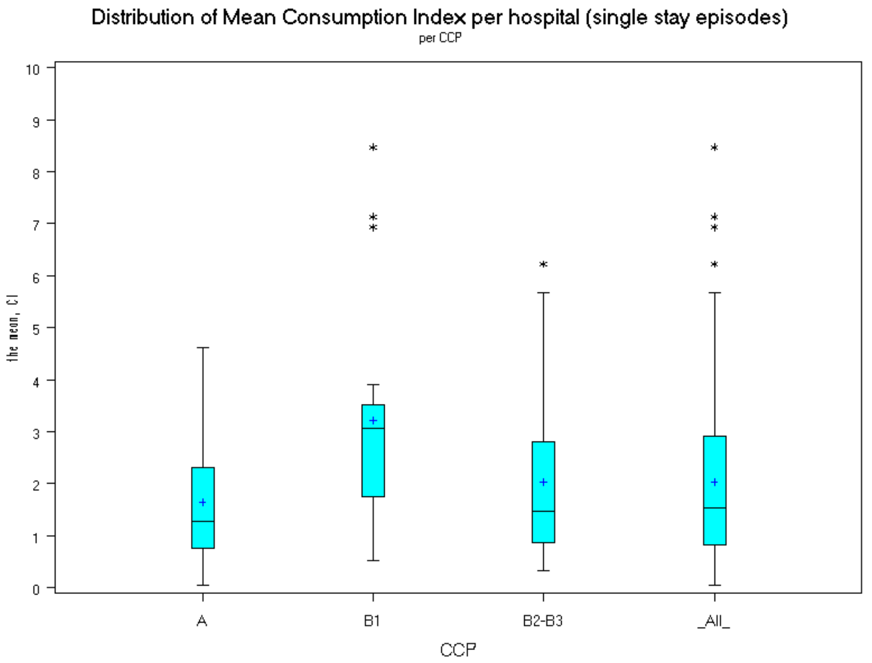
Table 14 : Average Consumption Index per hospital for Single Stay Episode (Low Risk Group):

CCP	Number of Hospitals	Number of stays	Mean	standard deviation	Median	Q1	Q3
A	63	1914	1.65	1.23	1.27	0.76	2.32
B1	20	1028	3.22	2.11	3.07	1.75	3.51
B2-B3	29	4270	2.04	1.55	1.46	0.87	2.80
All	112	7212	2.03	1.60	1.54	0.83	2.92

Note: The mean consumption index has been computed for each hospital separately (with more than 10 stays). This table presents the distribution of these means, which allows to assess the inter hospital variability.

Figure 23 shows these distributions as box-plots. Individual data per hospital are presented in Appendix E1.

Figure 23: Consumption Index calculated on Single Stay Episodes per Hospital per CCP (Low Risk Group).

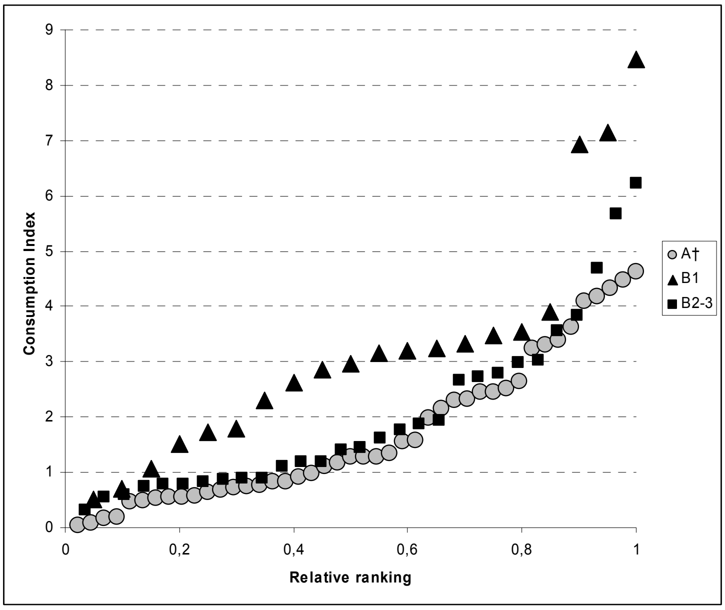


The consumption of B2-B3 hospitals that work in association with another B2-B3 hospital has been compared to the consumption of the B2-B3 hospitals that have no such association, and there was no evidence of a lower consumption in the hospitals working in association.

The Figure 24 shows the relative consumption index (CI) of single stays according to the relative ranking in a CCP. The relative ranking shows the place in the hierarchy: in 20 B1 hospitals, the lowest consumer gets rank 1/20, in 29 B2 1/29, in 44 A 1/44. The second lowest B1 gets 2/20, the second B2 2/29, the second A 2/44, etc

At all ranks, B1 consume always more. 3/20 B1 and 2/29 B2-3 hospitals show consumption profiles higher than expected. The three highest B1 hospitals show extraordinarily high consumption profiles: we would expect such high consumption indices in less than 1 per 1000 hospitals, compared to the Gaussian distribution of all the hospitals.

Figure 24: Ranking of Hospitals following Average Consumption Index of Single Stay Episodes (Low Risk Group).

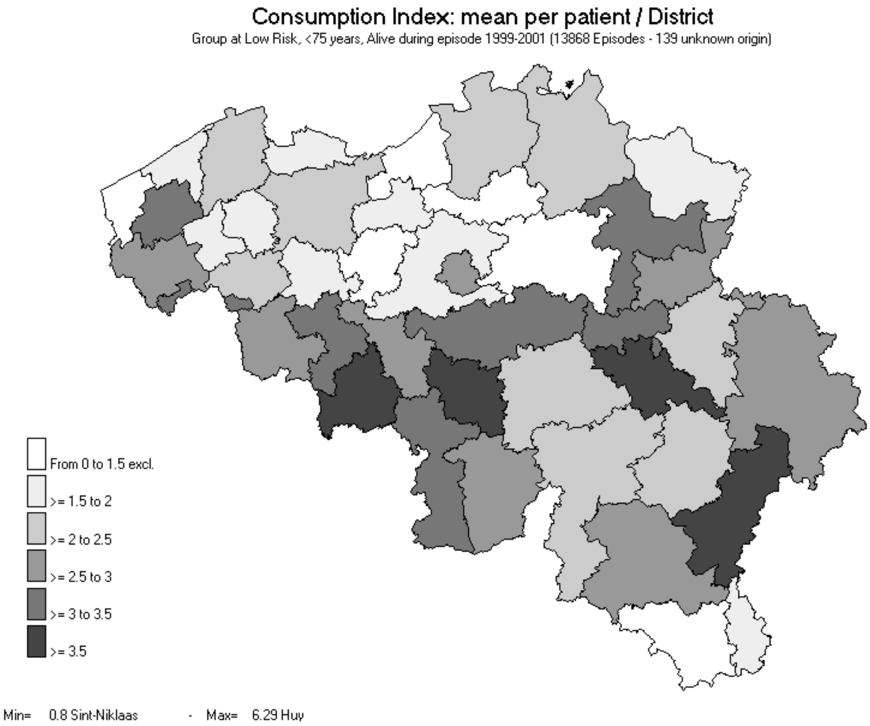


Hospitals with more than 19 single stays are included.

Consumption index of patient episodes.

The consumption index was computed per patient of the Low Risk Group on his entire episode. The result could not be assigned to one single hospital. The mean consumption index was then computed per residence district of the patient. Figure 25 shows the geographical variation in mean consumption index per patient.

Figure 25: Consumption Index calculated on entire Episode per patient (Low Risk Group).



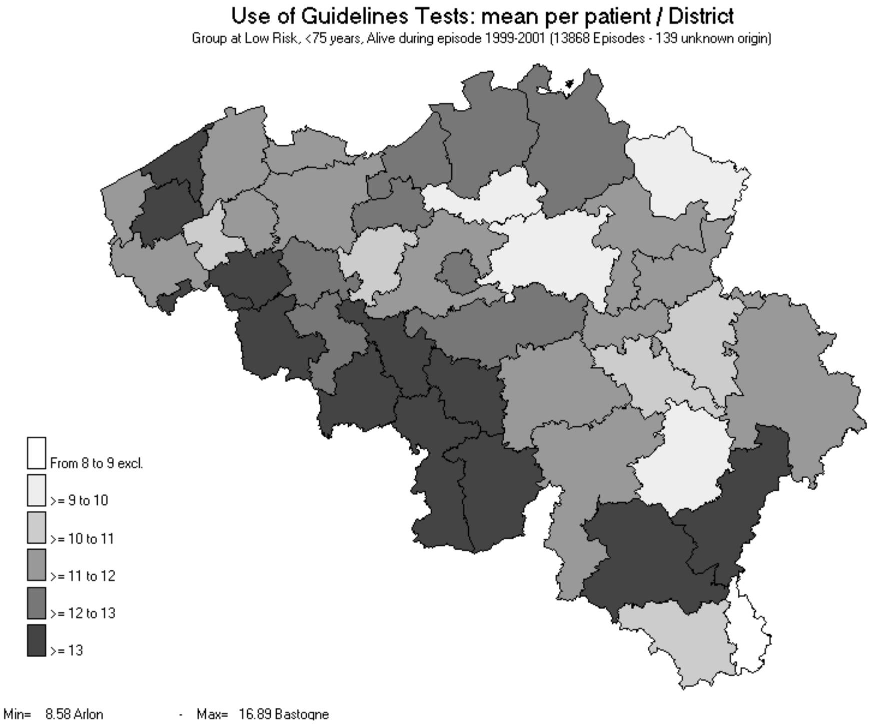
Use of Tests advocated by guidelines

While the previous results were focused on the consumption of diagnostic tests not routinely recommended in low risk MI by guidelines, the use of five tests advocated by guidelines was computed per patient. The total number of the five following tests used during the whole Episode of care of Low Risk Group patients were added up :

- Chest X-Ray
- ECG-Monitoring
- Echocardiography
- Exercise testing
- Rest ECG

Figure 26 shows the geographical variation in use of tests advocated by the Guidelines per patient. The variation appears to be relatively smaller than in the case of the Consumption Index.

Figure 26:



4.2.4. Variability in Therapeutics

Reperfusion and Revascularization

To examine the differences in treatment practice between hospitals, the level of analysis is not the episode or patient anymore but the stay, so that the treatments received during a particular stay are assigned to the hospital that delivered them.

Amongst 23376 stays of 13868 patients in the Low Risk Group, 23.1% stays were index admissions from patients treated by thrombolysis, 33.6% were stays from patients who underwent a PCI, 4.9% stays from patients who had a CABG and 43.7% stays from patients who were treated conservatively. These percentages amongst the 13868 index admissions were respectively 38.9%, 29.8%, 1.8% and 39.2%.

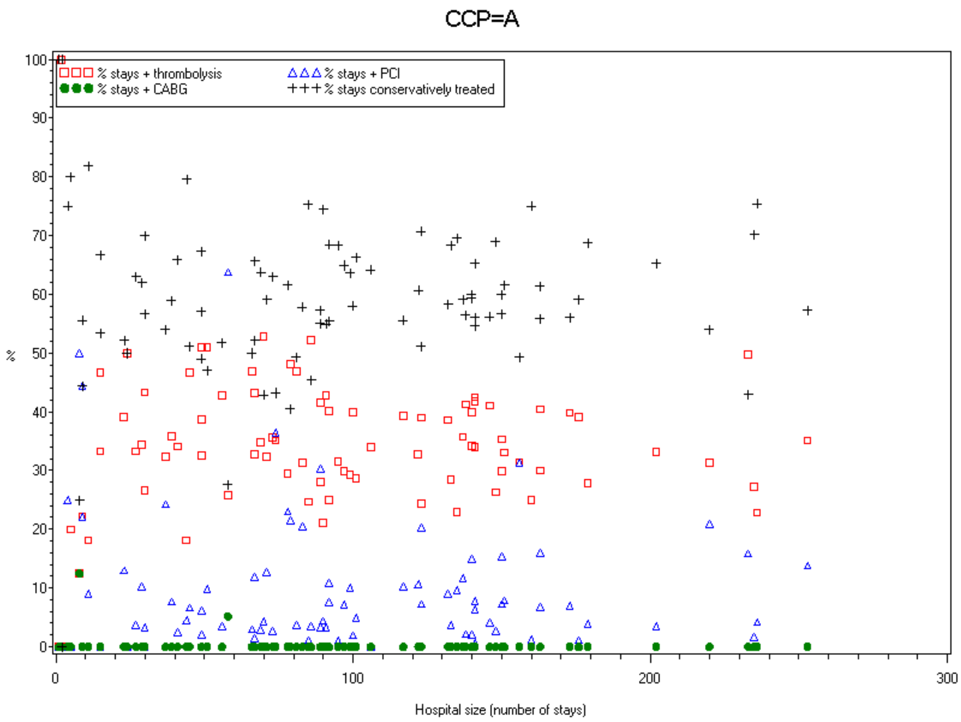
Table 15 summarizes the distribution of these percentages, the details per hospital can be found at Appendix E3.

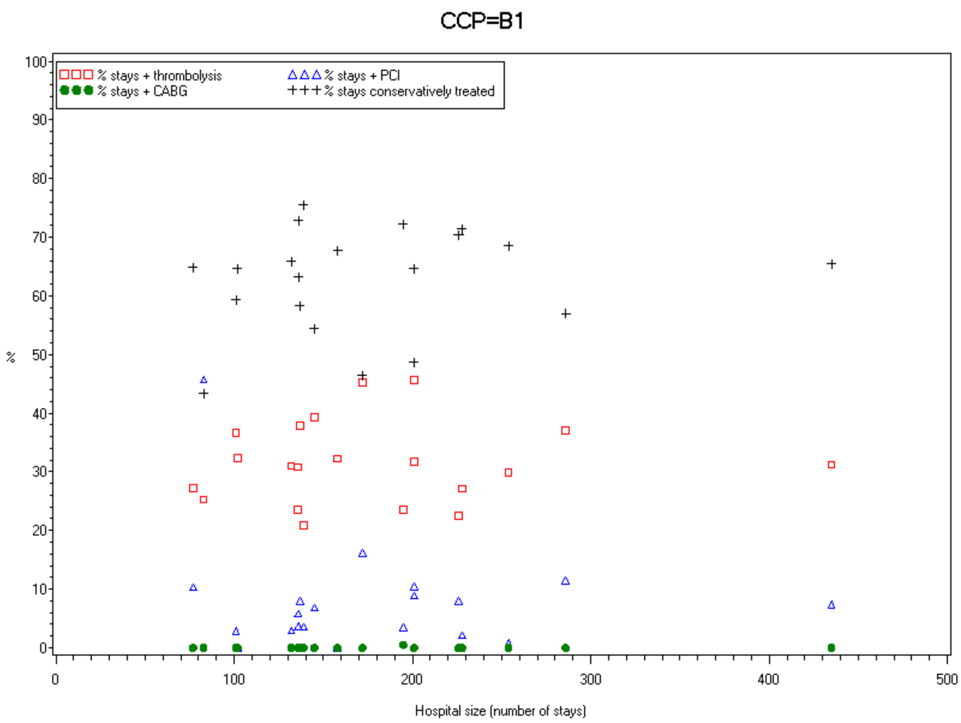
Table 15: Percentage of Stays and Index admissions per Hospital per treatment (Low Risk Group).

	All stays							Index admissions						
CCP	n Hosp	N stays	mean	std	median	Q1	Q3	n Hosp	N index	mean	std	median	Q1	Q3
Percentage stays with Thrombolysis (%)														
A	78	8069	35.5	8.2	34.4	29.9	41.1	76	5908	48.2	9.4	47.9	43.2	54.2
B1	20	3544	31.6	7.1	31.2	26.2	36.8	20	2452	44.7	9.3	44.6	37.0	51.3
B2-B3	29	11711	15.8	9.0	15.4	8.2	21.3	29	5471	27.3	10.9	29.4	19.0	35.9
All	127	23324	30.4	11.5	31.4	23.5	39.0	125	13831	42.8	13.0	43.8	34.8	52.6
Percentage stays with PCI (%)														
A	78	8069	8.8	10.0	6.3	2.7	10.9	76	5908	11.0	12.2	7.8	3.0	14.2
B1	20	3544	8.0	9.9	6.4	3.0	9.7	20	2452	9.8	10.9	8.5	3.6	12.3
B2-B3	29	11711	56.3	11.0	55.6	51.0	63.3	29	5471	57.6	13.9	60.2	53.1	67.6
All	127	23324	19.5	22.5	8.0	3.5	31.4	125	13831	21.6	23.4	10.6	4.0	36.0
Percentage stays with CABG (%)														
A	78	8069	0.0	0.3	0.0	0.0	0.0	76	5908	0.0	0.2	0.0	0.0	0.0
B1	20	3544	0.1	0.2	0.0	0.0	0.0	20	2452	0.0	0.0	0.0	0.0	0.0
B2-B3	29	11711	39.3	26.3	31.0	18.0	51.0	29	5471	8.4	4.5	8.0	6.0	11.0
All	127	23324	9.0	20.7	0.0	0.0	0.0	125	13831	2.0	4.2	0.0	0.0	0.0
Percentage stays with conservative treatment (%)														
A	78	8069	59.3	9.4	59.0	54.1	65.7	76	5908	46.5	9.8	47.2	39.2	52.7
B1	20	3544	62.8	9.0	64.8	57.7	69.4	20	2452	49.9	10.2	48.6	41.3	57.9
B2-B3	29	11711	27.4	9.6	28.2	19.5	32.5	29	5471	26.3	9.2	24.6	20.9	29.6
All	127	23324	52.6	16.7	56.7	43.2	64.9	125	13831	42.3	13.2	44.2	33.5	51.6
Note: The percentages of stays and index admissions with a specific treatment have been computed for each hospital separately (with more than 10 stays). This table presents the distribution of these percentages, which allows to assess the inter hospital variability.														

Figure 27 shows that, except rare cases, there is no relation between treatment in a hospital and the number of patients admitted to this hospital.

Figure 27: Percentage of Stays receiving each type of Treatment by Number of Stays per Hospital (Low Risk Group).





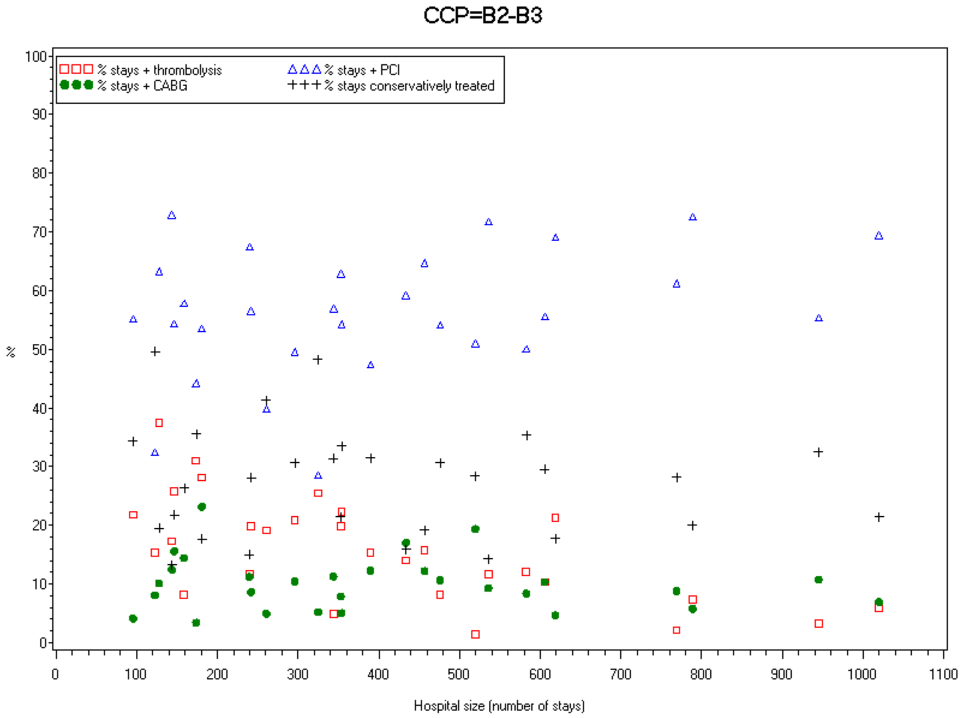
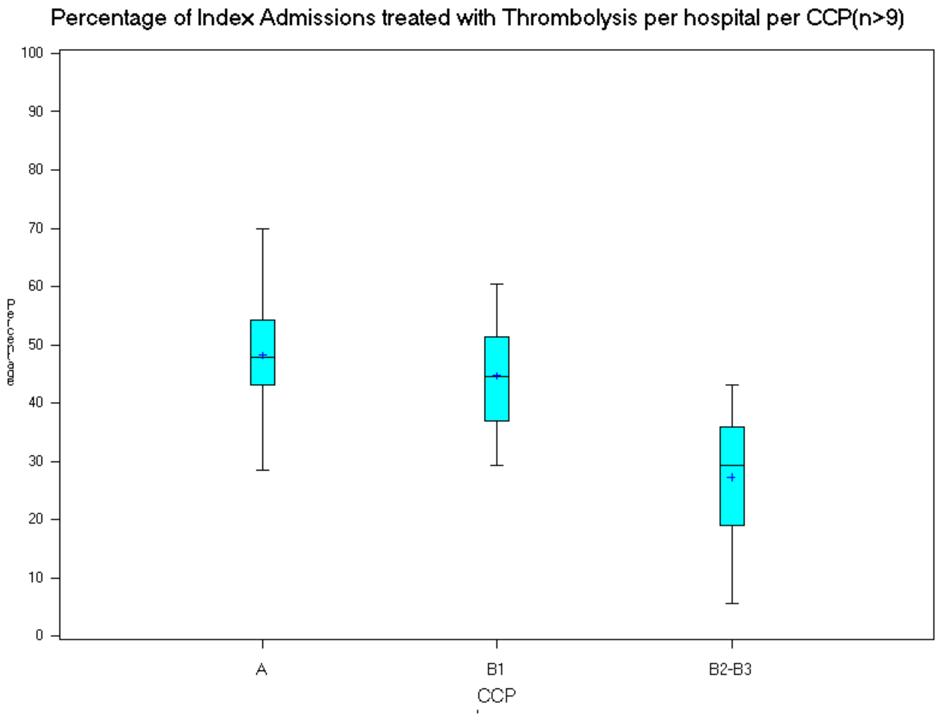
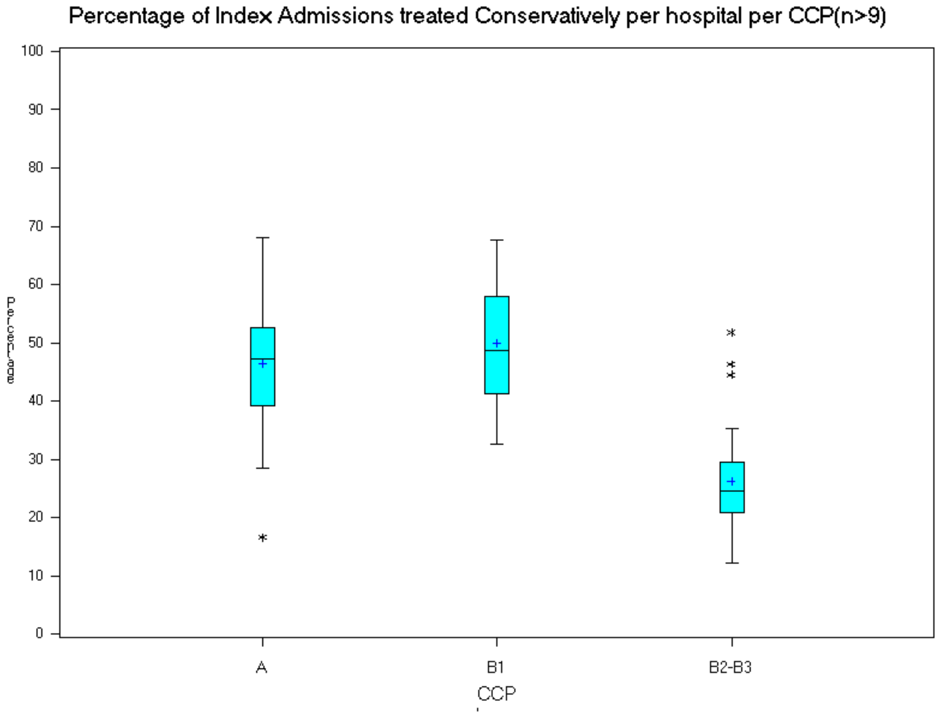


Figure 28 presents in three graphs, the distributions of percentages of Index Admissions of patients respectively treated with Thrombolysis, treated conservatively and treated with PCI (in B2-B3 hospitals for PCI).

Figure 28: Percentage of Index Admissions per hospital, per CCP, following the treatment (Low Risk Group).





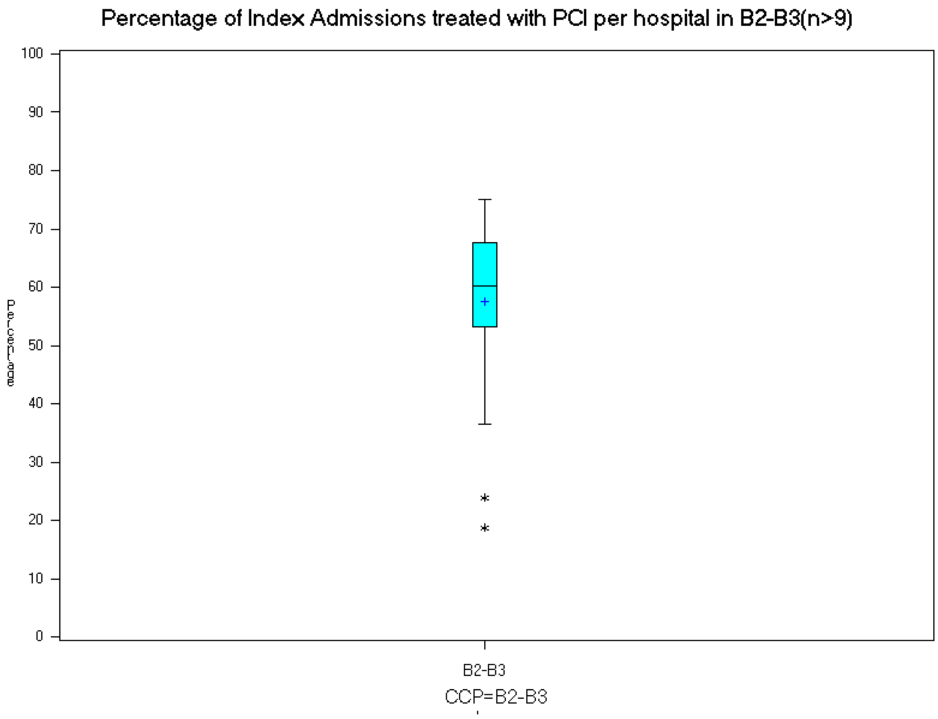


Table 16 shows that the percentage of patients who were reperfused during their index admission (per definition), is not very different from one Cardiac Care Program to another; maybe slightly lower in B1 hospitals. In A and B1 hospitals, reperfusion will be done mostly by thrombolysis and by Urgent PCI in B2-B3 hospitals. Concerning the revascularization at the end of Episode in function of the CCP of index admission, patients starting their episode In B2-B3 hospitals are more likely to be revascularized during their episode than if their index admission is spent in another CCP.

Table 16: Reperfusion (during Index Admission) and Revascularization (during Episode) per Index Admission Hospital (Low Risk Group).

			% index admission with reperfusion					% index admission of patients revascularized at the end of Episode				
CCP	n hosp	n index	mean	std	median	q1	q3	mean	std	median	q1	q3
A	76	5908	48.7	9.3	48.4	43.4	55.0	48.6	12.2	48.3	39.9	58.0
B1	20	2452	44.9	9.1	44.6	37.0	51.3	46.8	12.2	47.8	36.7	53.9
B2-B3	29	5471	48.6	7.6	49.7	44.2	53.8	69.2	13.4	71.6	66.4	79.0
All	125	13831	48.1	8.9	48.3	43.4	54.0	53.1	15.3	51.9	42.0	64.0
Note: The percentages of reperfusion and revascularization have been computed for each hospital separately (with more than 10 stays). This table presents the distribution of these percentages, which allows to assess the inter hospital variability.												

Drug Treatments

Beta-blocker use

Amongst the 13868 patients belonging to the Low Risk Group, 11325 patients (81.7%) received at least one beta-blockade product during their episode of care. The oral form alone was prescribed to 11153 patients (80.4 %), amongst whom 1937 patients received both forms (14 %) while a few 172 patients (1.24%) received the parenteral form only. 10637 patients (76.7%) have received one beta-blocker dose at least during their first stay at hospital. This percentage decreases for the following stays of the episodes (52.9% amongst the second stays, 56.5% amongst the third ones and 56.5% amongst the fourth ones).

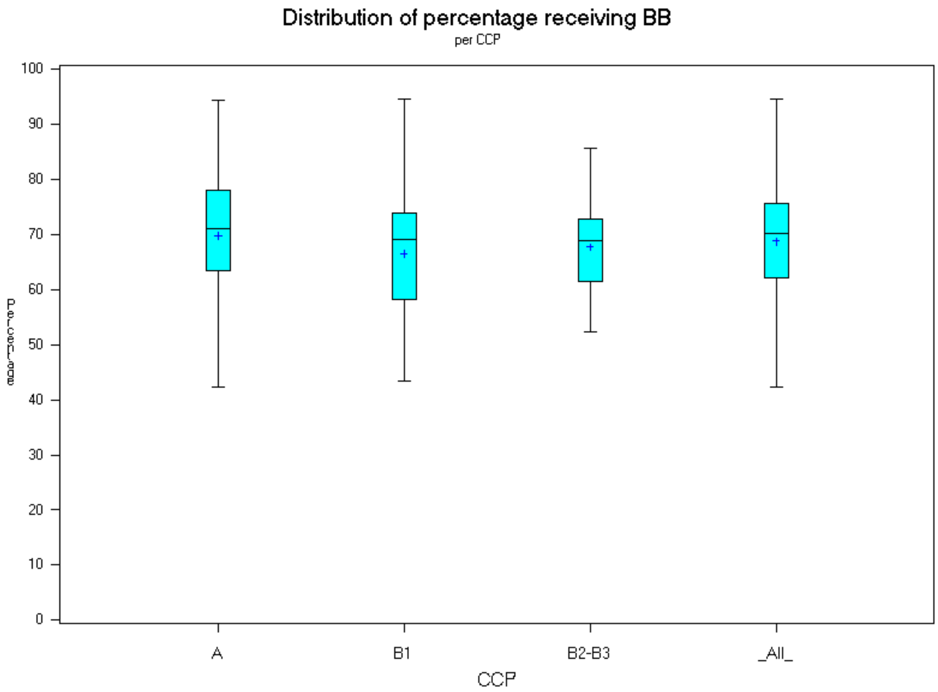
If we consider all 23376 stays belonging to the episodes from the homogeneous group, we may see the use of beta-blockers is not absolutely constant from one hospital to another. There was no significant difference between the three different Cardiac Care Programs, as seen on Figure 29 and Table 17. The distribution is presented on all 127 hospitals with at least 10 stays.

Table 17 : Percentage of Stays receiving Beta-blockers per Hospital (Low Risk Group):

CCP	Number of Hospitals	Number of stays	Mean	standard deviation	Median	Q1	Q3
A	78	8069	69.7%	12.0%	71.1%	63.4%	78.1%
B1	20	3544	66.5%	12.5%	69.1%	58.2%	73.9%
B2-B3	29	11711	67.7%	8.64%	68.9%	61.6%	72.8%
All	127	23 324	68.8%	11.4%	70.2%	62.1%	75.5%
Note: The percentage of stays with beta-blockers has been computed for each hospital separately (with more than 10 stays). This table presents the distribution of these percentages, which allows to assess the inter hospital variability.							

The Q1 value tells us that 25% of A hospitals give beta-blockers to less than 63.4% of their stays; this limit is 58.2% for B1 hospitals and 61.6% for B2-B3 hospitals.

Figure 29 : Percentage of stays receiving beta-blockers per Hospital per CCP (Low Risk Group).



The lowest percentage per hospital was found amongst A hospitals (42.3%).

Platelet Glycoprotein IIb/IIIa Inhibitor: abciximab.

We analyzed the number of patients receiving at least one dose of abciximab level 5 B01AC13 from the Anatomical Therapeutic Chemical (ATC) classification. The only brand product in Belgium was Reopro©, reimbursed since March 1999. We could not analyze the consumption of Tirofiban since this product was not reimbursed before February 2002 (and hence not present in the drugs data). Eptifibatide does not belong to the Belgian pharmacopoeia.

Amongst the 13868 patients belonging to the Low Risk Group, 2347 patients (16.9%) received at least one dose of abciximab during their episode of care. 1628 patients (11.7%) have received one dose at least during their first stay at hospital. This percentage was 18.1 % amongst the second stays, 22.3 % amongst the third ones and 18.1% amongst the fourth ones.

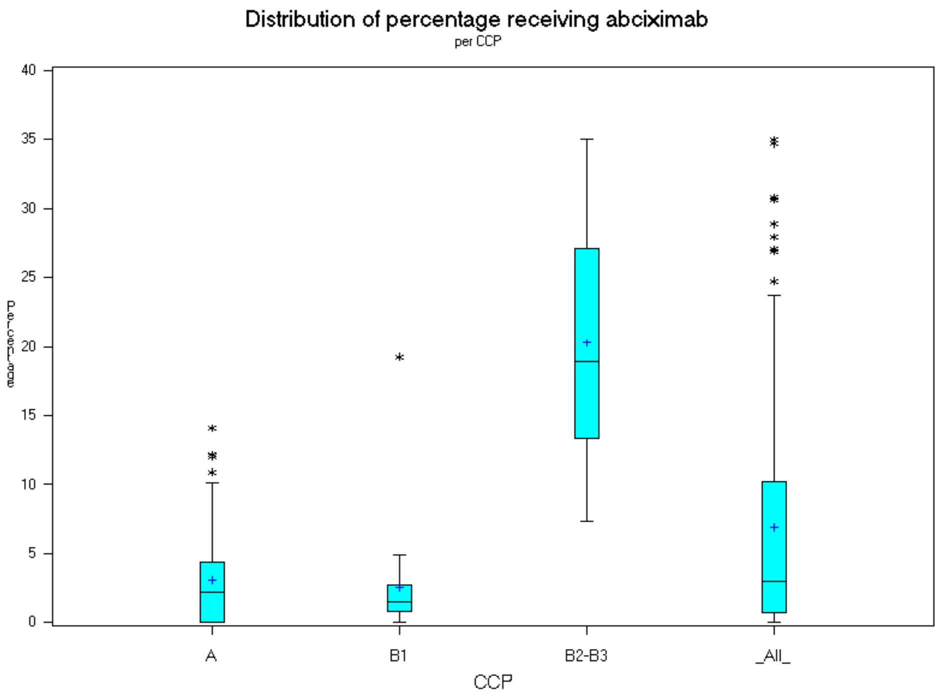
If we consider all 23376 stays belonging to the episodes from the homogeneous group, we may see the use of abciximab is not absolutely constant from one hospital to another. There was a difference between the three different Cardiac Care Programs, as seen on Figure 30 and Table 18. The distribution is shown on all 127 hospitals with at least 10 stays.

Table 18 : Percentage of Stays receiving abciximab per Hospital (Low Risk Group):

CCP	Number of Hospitals	Number of stays	Mean	standard deviation	Median	Q1	Q3
A	78	8069	3.1%	3.4%	2.2%	0.0%	4.4%
B1	20	3544	2.6%	4.2%	1.5%	0.8%	2.7%
B2-B3	29	11711	20.3%	7.9%	18.9%	13.4%	27.1%
All	127	23 324	6.9%	8.8%	3.0%	0.7%	10.2%
Note: The percentage of stays with abciximab has been computed for each hospital separately (with more than 10 stays). This table presents the distribution of these percentages, which allows to assess the inter hospital variability.							

The Q1 value tells us that at least 25% of A hospitals does not give abciximab; 25% of B1 hospitals give this product to at least 0.78% of their stays, this limit is 13.4 % for B2-B3 hospitals. The use of abxicimab is thus clearly more important in B2-B3 hospitals.

Figure 30 : Percentage of stays receiving abciximab per Hospital per CCP. (Low Risk Group)



Link between treatment in B2-B3 and transfer to B2-B3

Patients may be transferred by an A or B1 hospital towards a B2-B3 hospital to beneficiate from the interventional cardiology or cardiac surgery facility of the B2-B3 hospital. There is thus a link between the itinerary followed by the patient and the type of treatment he received. As seen before in the descriptive part, 6652 patients amongst the 13868 (48.0%) patients in the Low Risk Group were reperfused (thrombolysis, urgent PCI or urgent CABG during the index admission) and 7985 patients (57.6%) were revascularized during their episode. The pattern is not the same following the hospital itinerary as seen on Table 19 where the treatment in B2-B3 is given in function of their itinerary. 4270 single stay episodes were spent in B2-B3 hospitals; their rate of reperfusion (including thrombolysis) and rate of revascularization were compared with the patients with the index admission in A or B1 and a third stay after B2-B3 in A or B1 and finally with the patients who spent a second stay in A or B1 after an index admission in B2-B3.

Table 19 : Treatment in B2-B3 hospitals, Reperfusion and Revascularization during episode in 5 chosen scenarios (Low Risk Group):

		During Episode		During stay in B2-B3			
Followed itinerary	TOTAL	Reperfused	Revascularized	Thrombolysis	CABG	PCI	Urgent PCI
B2-B3 (single stays)	4270	48.3%	67.5%	26.8%	5.3%	62.8%	25.2%
A => **B2-B3** => A	1059	52.9%	78.2%		5.1%	73.4%	.
B1 => **B2-B3** => B1	472	49.8%	85.4%		5.3%	80.1%	.
B2-B3 => A	208	67.4%	82.2%	6.7%	3.8%	78.4%	61.5%
B2-B3 => B1	85	64.7 %	77.6%	3.5%	3.5%	74.1%	62.4%
A=>B2-B3	1947	47.7%	73.9%		13.5%	60.3%	
B1=>B2-B3	623	50.6%	89.9%		22.0%	68.1%	
Total of 5 scenarios	8664	49.6%	73.3%	13.4%	8.3%	65.3%	14.6%

The administration of any trombolytic product during a second stay in B2-B3 is not considered as thrombolysis treatment, as well as a PCI on the first day of a second stay is not considered urgent in the present study.

The percentage of revascularization in B2-B3 is higher when the itinerary involves transfers between Cardiac Care Programs. The percentage of patients who have received thrombolysis is higher when the entire single stay episode was spent only in B2-B3, for otherwise thrombolysis has been given in the other Cardiac Care Programs. Considering the percentage of revascularization of the itineraries with 2 stays and with 3 stays, they look similar. It seems that when a patient admitted in B2-B3 was then transferred to an A or B1 hospital, he actually was probably firstly admitted in an A or B1 hospitals for a few hours, thus not enough for the hospital to charge a pay per day and therefore this first very short stay is not to be found in the database. This is confirmed by the fact that urgent PCI is done for 25.2% of the single stay episodes in B2-B3. When the patient is transferred to another Cardiac Care Program, this percentage is much higher (61.5% and 62.4%), for most of them were transferred from an A or B1 hospitals in order to receive a PCI immediately in B2-B3.

4.2.5. Variability in Length of Stay

Descriptive Results for Length of Episode of Care

Summary statistics of the total length of episode (LOE) (including transfers and readmissions within 2 month) is presented in Table 20 for the Low Risk Group, by baseline characteristics. The mean LOE for the 13868 patients included in this group was 12.0 days (median 10 days; Q1 7 days; Q3 14 days, P99 = 44 days). Summary data for all patients are in Appendix F1 (34961 patients, mean LOE 14.2 days, median 11 days, Q1 7 days q3 17 days). Descriptive univariate statistics show that a number of patient characteristics influence the LOE: gender (female patients staying longer than male patients), age (LOE increasing with age), number of secondary diagnoses (LOE increasing with secondary diagnoses) and APR-DRG (LOE longer for CABG, APR-DRG 165). Patients admitted to an A or B1 hospital have on average an episode of care 2 days longer than patients first admitted to a B2-B3 hospital.

Table 20 Summary Statistics of Length of Episode (Low Risk Group)

Subgroup		N	mean	sd	median	q1	q3	min	max
Total number of patients		13868	12.0	9.3	10	7	14	1	242
Gender	Male	10989	11.7	8.8	10	7	14	1	242
	Female	2879	13.4	10.8	11	8	16	1	200
Age Group	15-49 years	2994	10.0	7.3	9	6	12	1	200
	50-59 years	3868	11.1	7.8	10	7	13	1	200
	60-69 years	4601	12.6	8.8	11	8	15	1	192
	70-74 years	2405	15.0	12.8	12	9	17	1	242
Year of Discharge	1999	4733	12.3	8.4	10	8	14	1	145
	2000	4514	12.2	9.2	10	7	14	1	192
	2001	4621	11.6	10.1	10	7	13	1	242
Number of Secondary diagnoses	<= 4	9153	10.8	6.6	10	7	13	1	116
	> 4	4715	14.5	12.6	11	8	17	1	242
CCP index admission	A	5945	12.7	8.6	11	8	15	1	192
	B1	2452	12.9	8.7	11	8	15	1	175
	B2-B3	5471	10.9	10.0	9	6	12	1	242
APR-DRG index admission									
165 (CABG)		244	22.5	17.1	19	14	25	7	200
174 (PTCA)		3076	9.6	8.0	8	6	11	1	200
190 (circulatory disorder with AMI)		9128	12.4	8.8	11	8	14	1	192
207 (other circulatory system diagnoses)		877	12.4	7.5	11	8	14	1	87
other		543	14.9	14.6	12	9	17	1	242

Descriptive Results by Stay in CCP

While the previous results focused on the Length of Episode for each patient, this section presents results based on individual stays. The average duration of the 23376 stays belonging to episode of care of the 13868 patients from the Low Risk Group is 7.1 days (CCP A median 7 days, CCP B1 median 7 days and CCP B2-B3 median 5 days).

The LOS of the index admission was on average 8.8 days (median 8 days). The following stays in episode of care have shorter duration: median 2 days for second stay, 3 days for third stay and 4 days for the 3% of patients who had a 4th stay at the end of Episode of care.

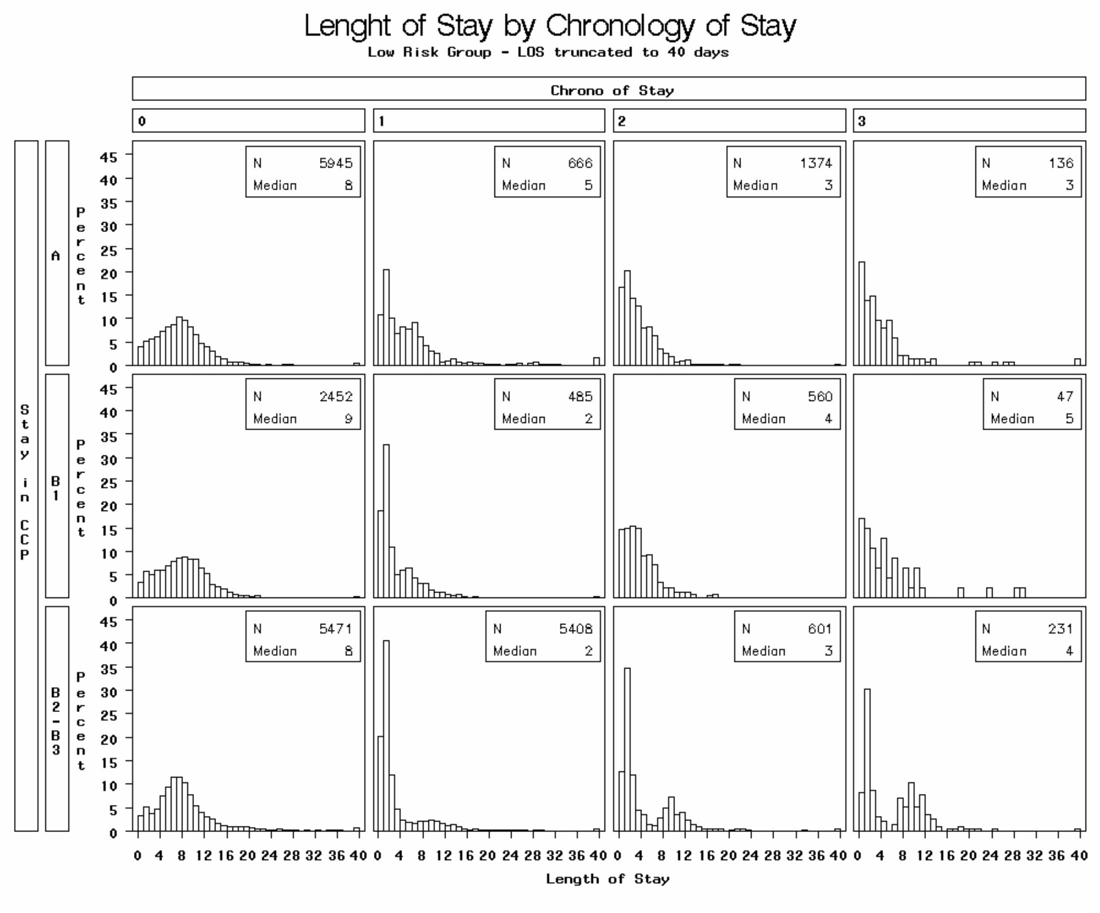
Table 21: Summary Stats on Length of Stay, All Stays in Cardiac Care Program (Low Risk Group)

Subgroup	subcat	N	mean	sd	median	q1	q3	min	max
Total number of Stays		23376	7.1	7.0	6	2	10	1	206
CCP stay	A	8121	7.6	7.0	7	4	10	1	206
	B1	3544	7.8	6.2	7	3	11	1	87
	B2-B3	11711	6.6	7.2	5	2	9	1	182
Chronology of Stay	First Stay (index admission)	13868	8.8	6.5	8	5	11	1	174
	Second Stay	6559	4.6	7.6	2	2	5	1	206
	Third Stay	2535	4.8	5.1	3	2	6	1	96
	Fourth Stay	414	6.2	6.2	4	2	10	1	50
Treatment During Stay	Conservative Therapy	10223	6.9	7.6	6	2	9	1	206
	Thrombolysis	4195	9.0	6.4	9	6	11	1	174
	PCI	6451	4.9	5.4	3	2	7	1	145
	CABG	1039	13.3	6.5	12	10	15	3	67
	Thrombolysis and PCI	1361	8.1	4.7	8	6	10	1	52
	Thrombolysis and CABG	70	22.4	8.3	22	17	27	7	50
	PCI and CABG	31	19.6	11.1	17	12	25	7	53
	Thrombolysis, PCI and CABG	6	27.7	8.7	28	21	31	17	42

As shown in Figure 31, the shape of the distribution of the LOS is very different between the index admission stays (chrono 0) and the following stays (chrono 1, 2 or 3; transfers and readmissions):

- For the index admission stay (chrono 0), the LOS is approximately normally distributed, with a long right tail (LOS longer than 40 days are truncated to 40 days in Figure 31). The overall median LOS of index admission is 8 days in CCP A, 9 days in CCP B1 and 8 days in CCP B2-B3.
- For following stays, the distribution of the LOS is highly skewed, the majority of the stays being shorter than the index admission (median between 2 and 5 days)

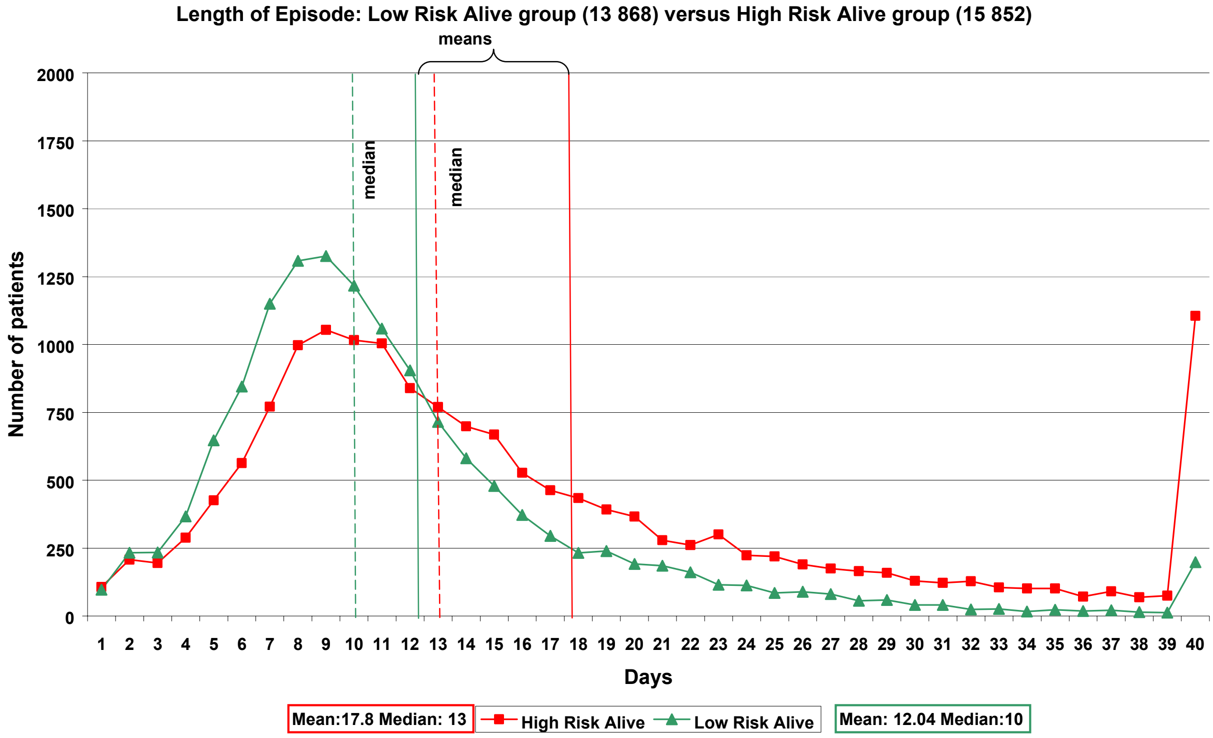
Figure 31: Lenght of Stay by Chronology of Stay and Cardiac Care Program (Low Risk Group)



Distribution of Episode LOS for Low Risk versus High Risk Patients

In order to compare the length of episode of the Low Risk Group with the length of the High Risk History and Alive at the end of Episode group, both distributions are presented on Figure 32. Diabetes, age or cardiovascular antecedents are the three main possible factors that can lead to the High Risk group, followed marginally by the classification into one of the following APR-DRG's:950-952 procedures unrelated with principal diagnosis, 004 tracheotomy, 956 ungroupable or 002 Heart/and or Lung transplant.

Figure 32



Relationship between LOS and Transfers Policy

Table 22 and Figure 33 below present the LOS of index admission (first stay) and the second stay (if any) by different types of transfers.

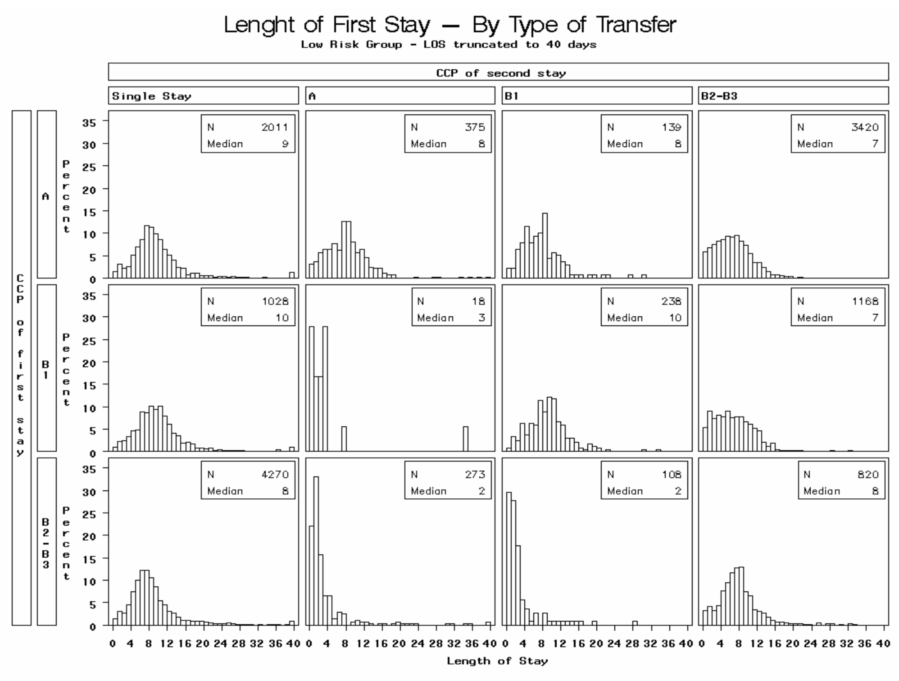
These tables and figures read as the following:

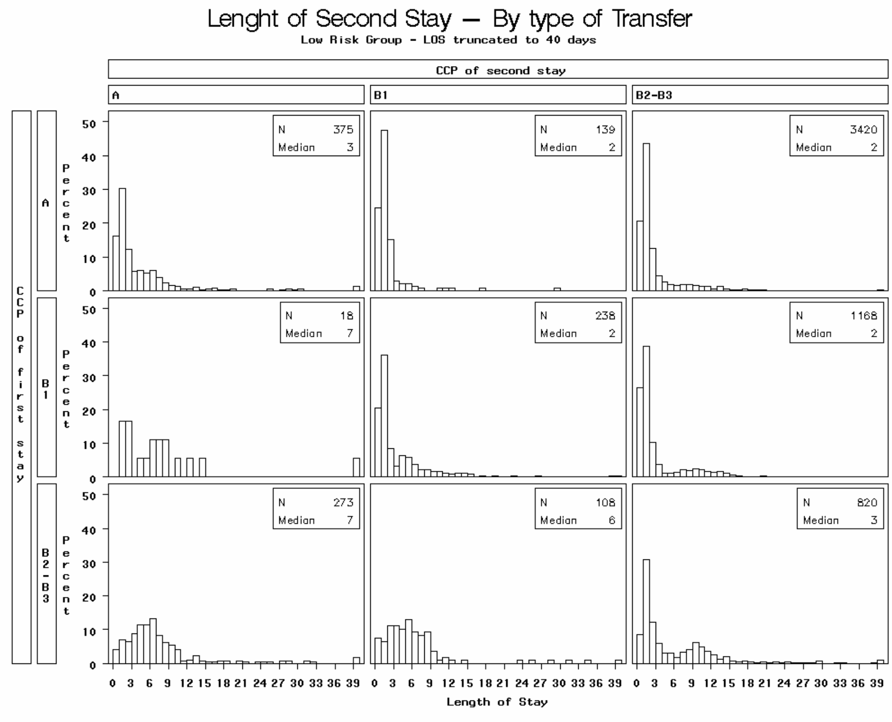
- For the 5945 patients from the Low Risk Group first admitted to a A hospital, the average LOS for the index admission is 8.5 days [median 8 days]. The 57.5% of these patients who were transferred to a B2-B3 hospital did spent on average 7.3 days in the A hospital (median 7 days) for the first stay, and then 3.8 days in the B2-B3 hospital (median 2.0 days) for the second stay. For the 33.8% of the patients who had single stay episode of care in A, the mean LOS was 10.4 days (median 9 days).
- For the 2452 patients from the Low Risk Group first admitted to a B1 hospital, the average LOS for the index admission is 9 days. The 47.6% of these patients who were transferred to a B2-B3 hospital did spent on average 7.4 days in the B1 hospital (median 7 days) for the first stay, and then 3.9 days on average in the B2-B3 hospital (median 2.0 days) for the second stay. For the 41.9% of the patients who had a single stay episode of care in B1, the average LOS was 10.9 days (median 10 days).
- For the 5471 patients from the Low Risk Group first admitted to a B2-B3 hospital, the average LOS for the index admission is 9.1 days (median 8 days). The majority of these patients had a single stay episode (78%), which was on average 9.6 days long (median 8 days). The 5.0 % (respectively 2.0%) of the patients who were transferred to an A (respectively to a B1 hospital) did spent on average 4.4 days (median 2 days) in the B2-B3 hospital (respectively 4.5 days, median 2 days) for the first stay and 9.5 days in A hospital (respectively 7.2 days in the B1 hospital) for the second stay.

Table 22: LOS of First stay and of Second Stay, by CCP of Index admission and Type of Transfer (Low Risk Group)

	N	%	LOS sej 1 mean/median	LOS sej2 mean/median
First Stay in CCP A	5945	100%	8.5/8	
Single stay episode	2011	33.8	10.4/9	-
Second Stay in CCP A	375	6.3	8.7/8	5.6/3
Second Stay in CCP B1	139	2.3	8.3/8	2.8/2
Second Stay in CCP B2-B3	3420	57.5	7.3/7	3.8/2
First Stay in CCP B1	2452	100%	9.1/9	
Single stay episode	1028	41.9	10.9/10	
Second Stay in CCP A	18	0.7	4.6/3	14.1/7
Second Stay in CCP B1	238	9.7	9.7/10	4.4/2
Second Stay in CCP B2-B3	1168	47.6	7.4/7	3.9/2
First Stay in CCP B2-B3	5471	100%	9.1/8	
Single stay episode	4270	78.0	9.6/8	-
Second Stay in CCP A	273	5.0	4.4/2	9.5/7
Second Stay in CCP B1	108	2.0	4.5/2	7.2/6
Second Stay in CCP B2-B3	820	15.0	8.4/8	6.7/3

Figure 33: Length of First and Second Stay, by CCP of First and Second Stay (Low Risk Group)



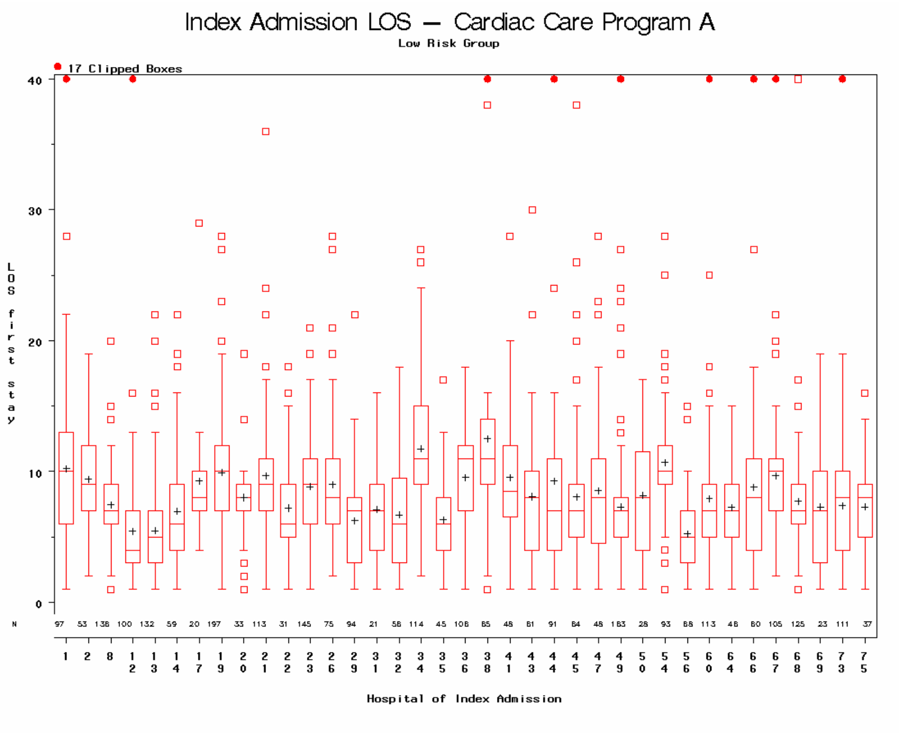


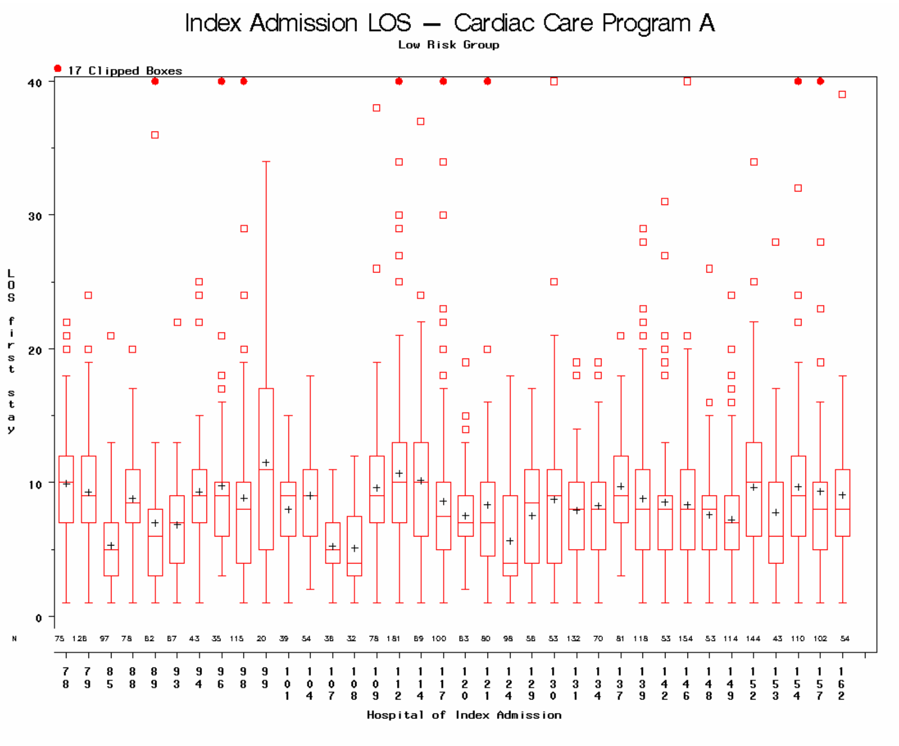
Inter and Intra Hospital Variability

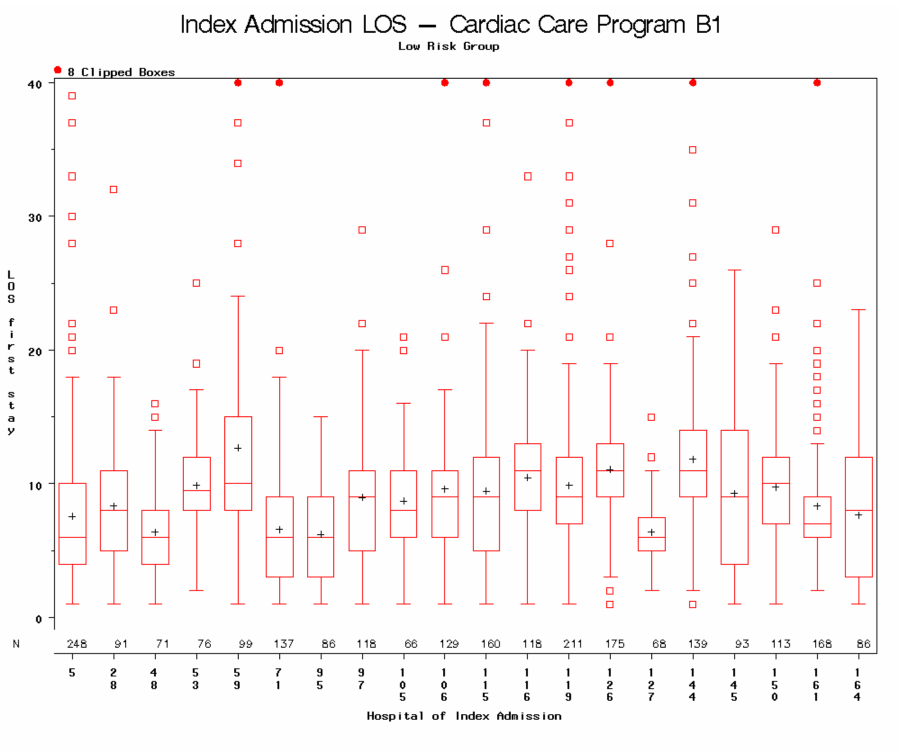
The inter and intra hospital variability are explored on the index admission LOS only, i.e. without taking into account transfers and readmissions occurring after index admission. The mean index admission LOS was 8.8 days (median 8 days, SD 6.5 days). The average index admission LOS was 8.5 days (median 8 days) for patients in CCP A, 9.1 days (median 9 days) for patients in CCP B1 and 9.1 days (median 8 days) for patients in CCP B2-B3.

As a visual illustration of the within hospital variability, box plots of index admission LOS are presented in Figure 34 for all the hospitals from each Cardiac Care Program (a hospital is displayed if it has a minimum of 20 patients with index admission).

Figure 34: Box Plots Index Admission LOS by Hospital of Admission, by CCP (Low Risk Group)







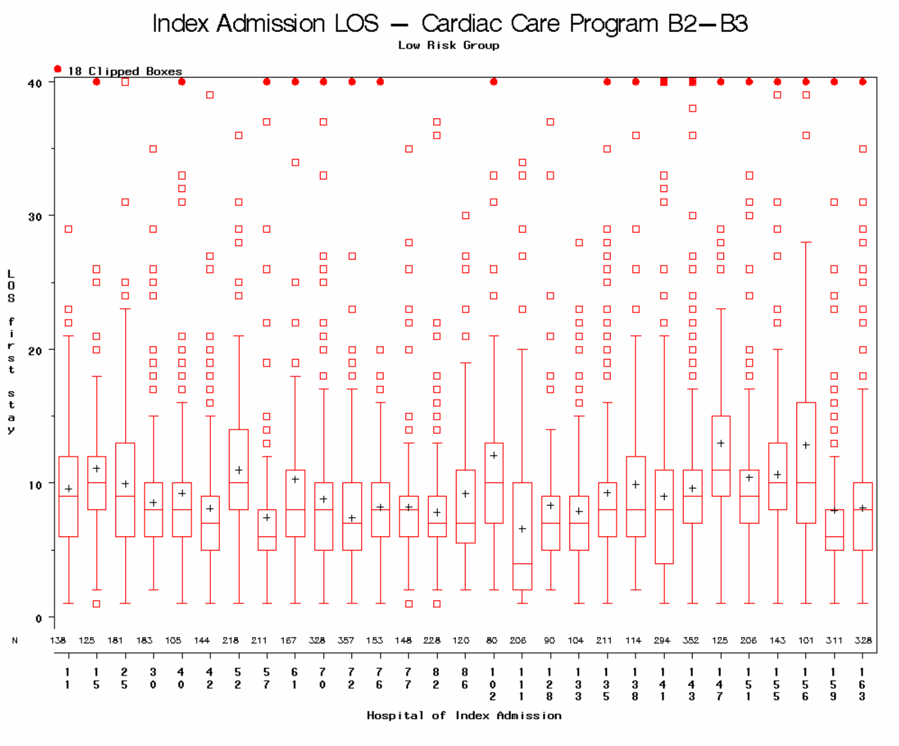
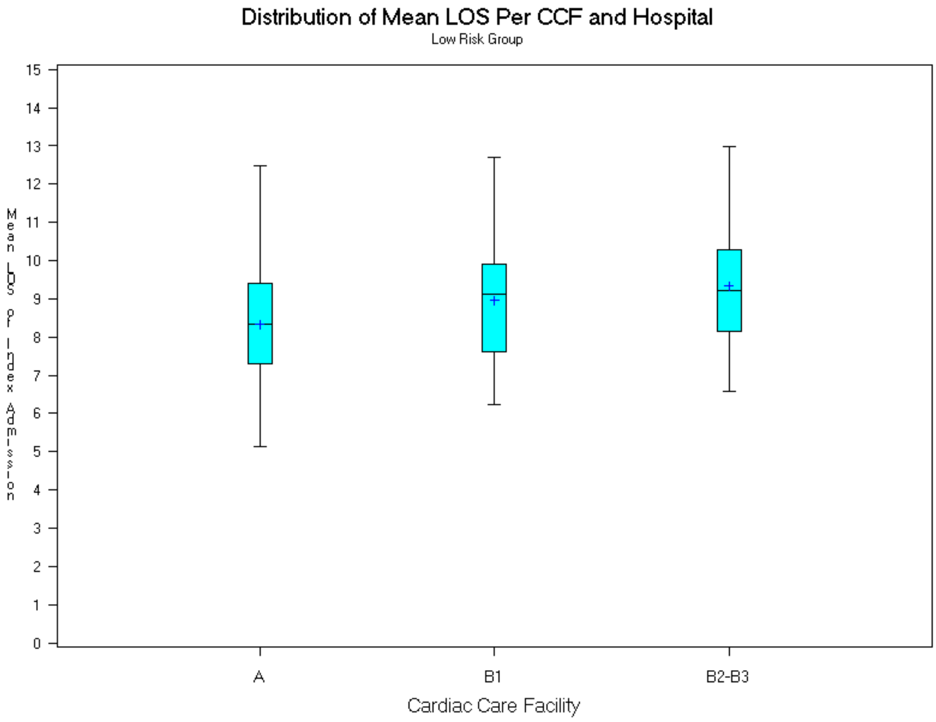


Figure 35 presents box-plots for the mean index admission LOS per hospital. In A and B1, mean LOS of index admission ranged from 5 days to 12.5 days, while in B2-B3 mean LOS of index admission ranged from 6.5 days to 13 days.

Figure 35: Box-Plots of Mean Index Admission LOS, per Hospital and Cardiac Care Program (Low Risk Group)



Multilevel Analysis of Index LOS for Single Stay Patients

Patients included in the following analyses are the patients from the Low Risk Group, and that have a single stay episode of care (these patients have not been transferred or readmitted within 2 months after first admission). This represents a total of 7309 patients (2011 in CCP A, 1028 in CCP B1 and 4270 in CCP B2-B3) from 132 hospitals (83 in CCP A, 20 in CCP B1 and 29 in CCP B2-B3).

Results of the partition of variance are in Table 23, and effect of patient and hospital characteristics are in Table 24.

The partition of variance in the empty model (Model 1) shows that, for the 3 CCP, the amount of the total variability that is due to the hospitals is low (3% for CCP A, 9% for CCP B1 and 6% for CCP B2-B3). The variability within the hospitals is much larger than the variability between the hospitals.

When patient individual characteristics are taken into account (Model 2, individual characteristics are age, gender, discharge year, number of secondary diagnoses, cardiac failure and APR DRG of index admission), the contribution to the total variability by the hospitals rises slightly (ICC = 7% for CCP A, 15% for CCP B2-B3 and 8% for CCP B1), while the within hospitals variability decreases substantially, leading to percentages of explained variation within the hospitals (R^2_1) ranging from 25% (CCP A) to 41% (CCP B2-B3).

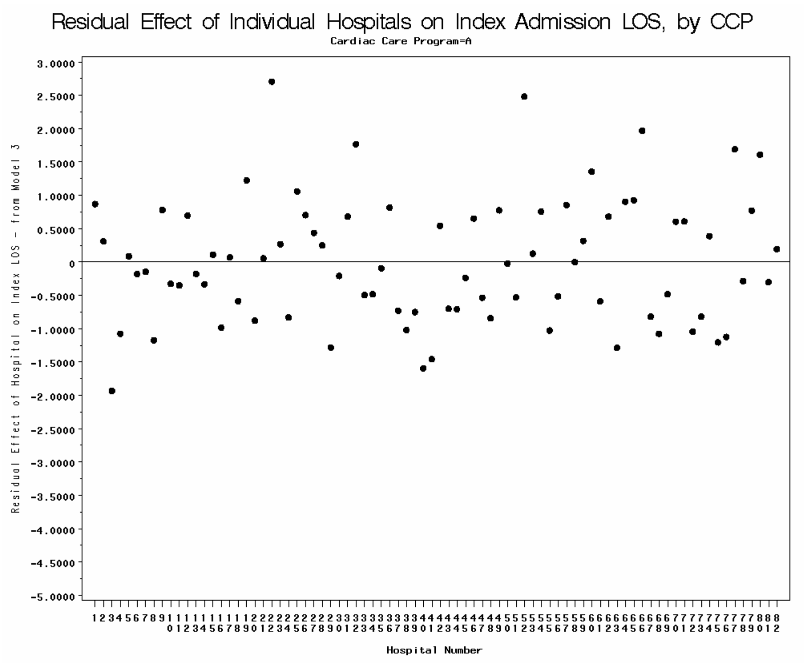
Results from Model 3 show that the inclusion of the hospital covariates (average annual volume of index admissions) and type of hospital (only for B2-B3 hospitals) do not help to reduce the inter hospital variability.

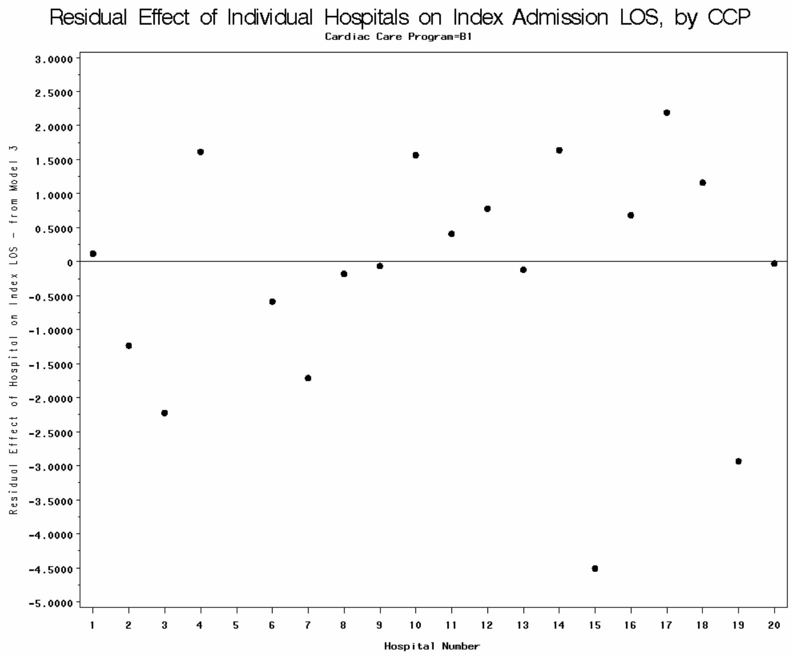
Figure 36 presents the hospital residual effects (after adjusting for patient and hospital covariates) on index admission LOS. Each dot represents the deviation from the overall mean of the hospitals LOS.

Table 23 : Partition of Variance for Index Admission LOS (Low Risk Group)

	CCP A	CCP B1	CCP B2-B3
Nr Hospitals	83	20	29
Nr Patients	2011	1028	4270
Nr Patients/Hospitals (range)	(1-96)	(21-92)	(69-293)
Model 1: Null Model			
σ^2_h (between hospitals)	1.2	3.4	2.1
σ^2_e (within hospitals)	33.5	32.8	33.0
ICC	0.03	0.09	0.06
Model 2: Model with Patients Characteristics (level1 covariates)			
σ^2_h (between hospitals)	1.7	3.9	1.6
σ^2_e (within hospitals)	24.3	21.8	19.0
ICC	0.07	0.15	0.08
R^2_1 (level 1)	0.25	0.29	0.41
Model 3: Model with Patients and Hospital Characteristics (level1 and level 2 covariates)			
σ^2_h (between hospitals)	1.7	4.3	1.3
σ^2_e (within hospitals)	24.2	21.8	19.0
ICC	0.07	0.16	0.06

Figure 36: Residual Effect of Individual Hospitals on Index Admission LOS (From Model 3) (Low Risk Group)





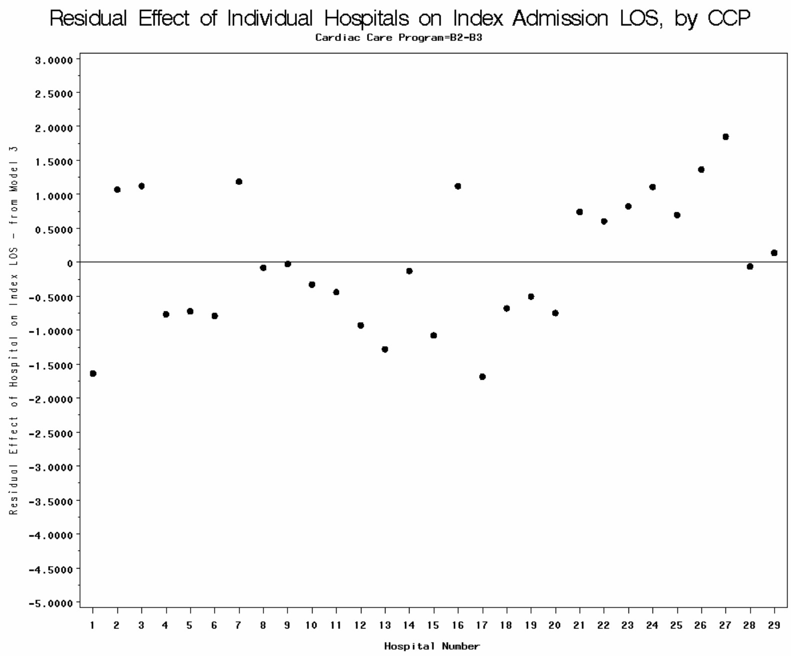


Table 24 presents estimation of patient and hospital characteristics of index LOS. Results are generally qualitatively consistent across the 3 CCP. The interpretation of this table is as followed. The intercept is the average LOS for the "reference" patient (chosen arbitrarily): a patient admitted in an A hospital, 70-74 years old, female, discharged in 2001, with less than 3 secondary diagnoses, with no pump failure, with a stay belonging to the APR-DRG 190 spends on average 9.7 days in the hospital (single stay). In the same CCP, a male patient, other things being equal, spends on average 1 day less than a female patient. A patient with shock spends, other thing being equal, 5 days more than a patient without pump failure. A patient with more than 8 secondary diagnoses spends, other things being equal; on average 7 days more than a patient with less than 3 secondary diagnoses.

Table 24 : Effect of Patient and Hospital Characteristics on Index LOS (Low Risk Group)

Factor	Level	Cardiac Care Program					
		A	SE	B1	SE	B2-B3	SE
Model 2 Patient Characteristics							
Intercept		**9.7**	**0.4**	**8.5**	**0.7**	**7.4**	**0.4**
Age	15-49 years	-3.3	0.4	-1.1	0.5	-1.6	0.2
	50-59 years	-2.5	0.3	-0.8	0.5	-1.3	0.2
	60-69 years	-1.8	0.3	0.3	0.4	-0.7	0.2
	70-74 years	**ref**		**ref**		**ref**	
Sex	Male	-0.9	0.3	-1.3	0.3	-0.5	0.2
	Female	ref		ref		ref	
Discharge	1999	1.2	0.3	0.6	0.4	1.1	0.2
	2000	0.7	0.3	0.6	0.4	0.6	0.2
	2001	**ref**		**ref**		**ref**	
Nr Secondary diagnoses	>8	7.3	0.6	6.2	0.6	6.7	0.3
	6-8	3.4	0.5	3.2	0.6	3.6	0.3
	4-6	2.2	0.4	2.2	0.5	1.8	0.2
	2-4	1.5	0.3	1.0	0.4	0.9	0.2
	<= 2	**ref**		**ref**		**ref**	
Pump Failure	Heart Failure	3.2	0.3	3.9	0.5	3.1	0.2
	Shock	4.9	0.5	7.8	0.7	5.4	0.3
	No failure	**ref**		**ref**		**ref**	
APR-DRG	174	1.0	0.8	-2.1	1.0	-0.1	0.2
	165	--	--	--	--	5.8	0.4
	207	0.4	0.4	-2.6	1.3	1.4	0.9
	oth	2.9	0.6	-0.5	0.8	1.8	0.3
	190	**ref**		**ref**		**ref**	
Model 3 Patient + Hospital Characteristics							
Type of Hospital	General	-	-	-	-	1.7	0.6
	University	-	-	-	-	**ref**	
Annual Volume (index admissions)	< 50 pat/y	-1.2	1.5	-	-	-	-
	50 -100 pat/y	-0.9	1.4	-0.8	1.7	0.1	0.8
	100 -150 pat/y	-0.3	1.5	-0.1	1.8	0.5	0.7
	150 -200 pat/y	ref		ref		-0.1	0.8
	200 -250 pat/y	-	-	-	-	0.5	0.9
	>= 250 pat/y	-	-	-	-	**ref**	

Early Discharge in Very Low Risk Group

To study the compliance to guidelines recommendation that patients with uncomplicated acute myocardial infarction should be considered for discharge within 4 days of admission, a very low risk population of patients was selected, consisting of the Low Risk Group, without CABG and without shock or heart failure during hospitalization. The very low risk group consists of 10945 patients (31% of all patients). Table 25 presents these results.

The percentage of patients with early discharge from their first stay in the episode of care (index admission) was 21%, and 8% if the total episode of care was taken into account (including all stays).

Table 25 : Early Discharge of Patients from Very Low Risk Population

CCP of Index Admission	N	n	%
Early discharge from index admission (LOS first stay <= 4 days)			
A	4660	1024	22.0
B1	1942	437	22.5
B2-B3	4343	840	19.3
Total	10945	2301	21.0
Early discharge from total episode of care (total LOS <= 4 days)			
A	4660	251	5.4
B1	1942	118	6.1
B2-B3	4343	511	11.8
Total	10945	880	8.0
N = number of patients in the very low risk population (=low risk population, alive at the end of episode, and no CABG at the end of Episode, and no shock, and no heart failure)			

4.2.6. Variability in Total Cost of Treatment

Cost of Thrombolysis only

In order to define the cost of an AMI treated with thrombolysis, we studied the single stay episode of the patients from the Low Risk Group, who received thrombolysis during their unique stay, PCI or CABG excluded. From 7309 single stay episode, we kept 1577 with thrombolysis only (i.e. without PCI or CABG). The mean partial bill for these stays was € 2705 (median € 2614; Q1: €1970; Q3: € 3172). Hospital day cost included, this amounts to a mean of € 5050 (median € 4671; Q1: € 3801; Q3: € 5812) with a mean length of stay at 10.8 days (median: 10 days; Q1: 8 days; Q3: 12 days).

gives the distribution of partial bill and LOS per CCP. The mean per hospital with at least 10 stays is given in Table 27.

Table 26 : Partial and Total bill (€) and LOE (days) (single stay episodes with thrombolysis only) (Low Risk Group)

CCP	N patients	Variable	Mean	Std Dev	Median	Lower Quartile	Upper Quartile
A	813	Length of episode Partial bill episode Total bill episode	11.1 2387.8 4621.9	8.0 1203.3 2288.2	10.0 2246.6 4268.8	8.0 1691.4 3480.1	13.0 2853.7 5189.2
B1	385	Length of episode Partial bill episode Total bill episode	11.1 3075.2 5405.5	6.5 982.3 1998.5	11.0 3015.4 5198.6	8.0 2463.5 4201.7	13.0 3569.2 6251.1
B2-B3	379	Length of episode Partial bill episode Total bill episode	9.8 3007.2 5608.4	9.3 1443.1 4286.9	9.0 2845.4 5148.7	7.0 2418.9 4233.9	11.0 3371.4 6226.2

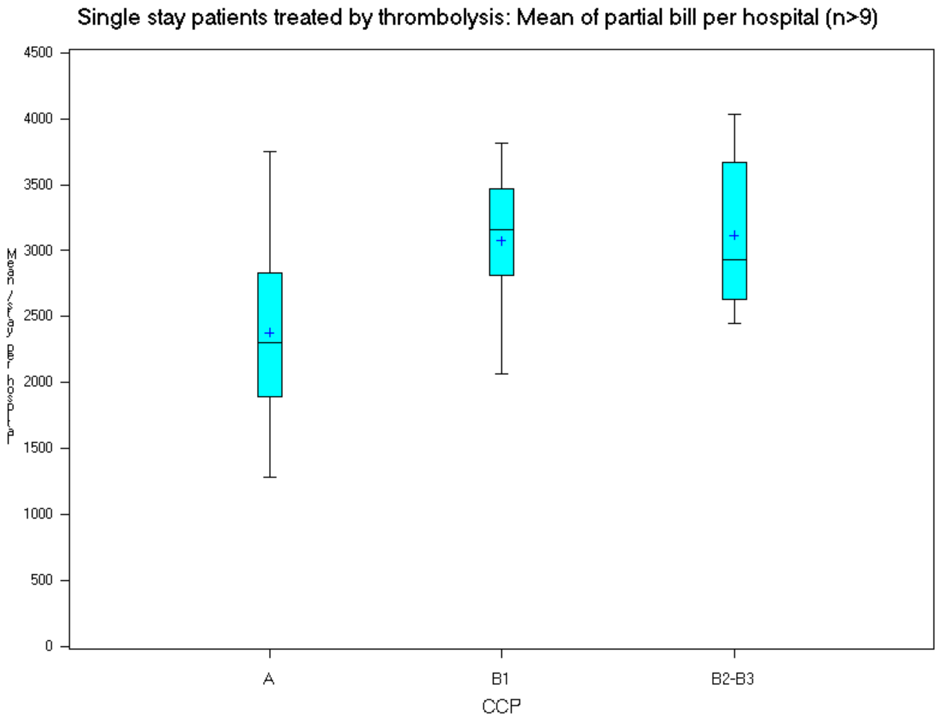
Table 27 : Partial and Total bill (€) per hospital.

			Partial bill					Total bill				
CCP	N hosp	N patients	Mean	Std dev	Median	Lower Quartile	Upper Quartile	Mean	Std dev	Median	Lower Quartile	Upper Quartile
A	34	624	2379.6	651.7	2307.1	1892.7	2829.4	4640.3	1049.7	4732.4	3915.4	5236.5
B1	16	357	3078.4	506.9	3156.4	2810.0	3469.1	5460.1	738.7	5524.9	4874.8	6072.4
B2-B3	19	332	3117.0	538.0	2934.2	2630.9	3669.3	5808.4	1673.0	5418.2	4547.4	6055.4
All	69	1313	2744.7	686.3	2754.9	2265.4	3269.4	5152.0	1292.1	4921.3	4458.2	5894.0

Note: The mean partial and total bill have been computed for each hospital separately (with more than 10 stays). This table presents the distribution of these percentages, which allows to assess the inter hospital variability.

A Hospitals seem to have a lower partial bill than other CCP.

Figure 37: Mean Partial bill per hospital (Low Risk Group)



Cost of Conservative treatment

In order to define the cost of an AMI treated conservatively, we studied the single stay episode of the patients from the Low Risk Group, who did not receive thrombolysis any PCI neither CABG during their unique stay. From 7309 single stay episode, 2686 were in this case. The mean partial bill for these stays was € 1838 (median €1610; Q1: €1100; Q3: € 2101). Hospital day cost included, this amounts to a mean of € 4110 (median € 3538; Q1: € 2634; Q3: € 4749) with a mean length of stay at 9.9 days (median: 9 days; Q1: 6 days; Q3: 12 days). Table 28 gives the distribution of partial bill and LOS per CCP. The mean per hospital with at least 10 stays is given in Table 29 .

As seen with the patients treated by thrombolysis, the A hospitals seems to achieve the cheapest conservative treatment.

Table 28 : Partial and Total bill (€) and LOE (days) (Single Stay Patients treated conservatively) (Low Risk Group)

CCP	N patients	Label	Mean	Median	Std Dev	Lower Quartile	Upper Quartile
A	1096	LOS episode Partial bill episode Total bill episode	10.0 1428.8 3445.0	9.0 1268.5 3068.6	7.6 1079.7 2349.9	6.0 768.0 2236.7	12.0 1746.0 4004.1
B1	580	LOS episode Partial bill episode Total bill episode	11.1 2153.0 4527.7	10.0 1886.8 3934.0	8.2 1515.6 2938.3	7.0 1440.3 3092.3	13.0 2485.5 5260.6
B2-B3	1010	LOS episode Partial bill episode Total bill episode	9.2 2100.1 4590.5	8.0 1763.4 3961.0	7.8 1811.5 3501.8	5.0 1332.9 2895.7	11.0 2247.2 5174.0

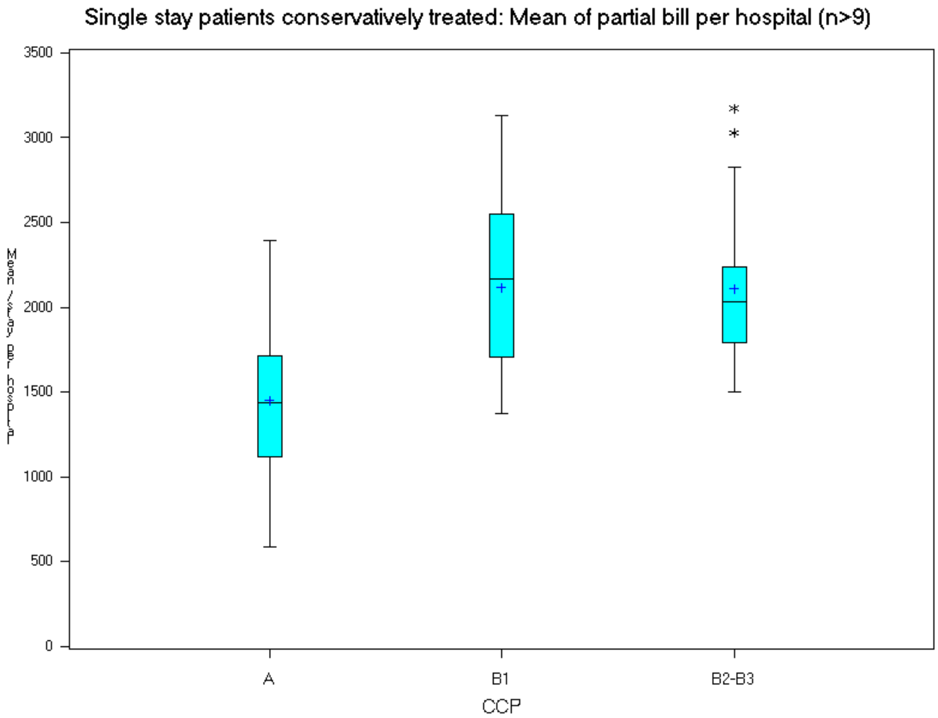
Table 29 : Partial and Total bill per hospital (€) (Single Stay patients treated conservatively) (Low Risk Group)

			Partial bill					Total bill				
CCP	N hosp	N patients	Mean	Std dev	Median	Lower Quartile	Upper Quartile	Mean	Std dev	Median	Lower Quartile	Upper Quartile
A	47	939	1449.5	403.0	1434.2	1120.2	1712.5	3430.9	678.1	3533.5	2819.8	3882.7
B1	20	580	2116.5	511.2	2170.2	1702.6	2546.1	4389.5	1019.2	4268.8	3651.2	4988.6
B2-B3	28	1001	2108.0	433.8	2029.7	1793.8	2240.3	4513.4	1177.1	4337.7	3558.4	4880.2
All	95	2520	1784.0	545.1	1774.3	1392.5	2167.5	3951.7	1050.4	3796.3	3209.2	4588.6

Note: The mean partial and total bill have been computed for each hospital separately (with more than 10 stays). This table presents the distribution of these percentages, which allows to assess the inter hospital variability.

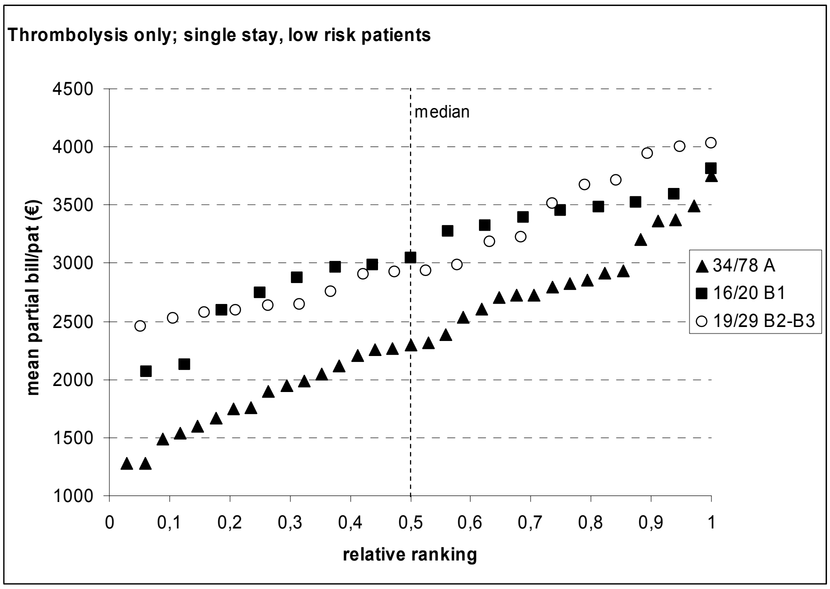
The mean partial bill per hospital of index admission with at least 10 stays is given in Figure 38.

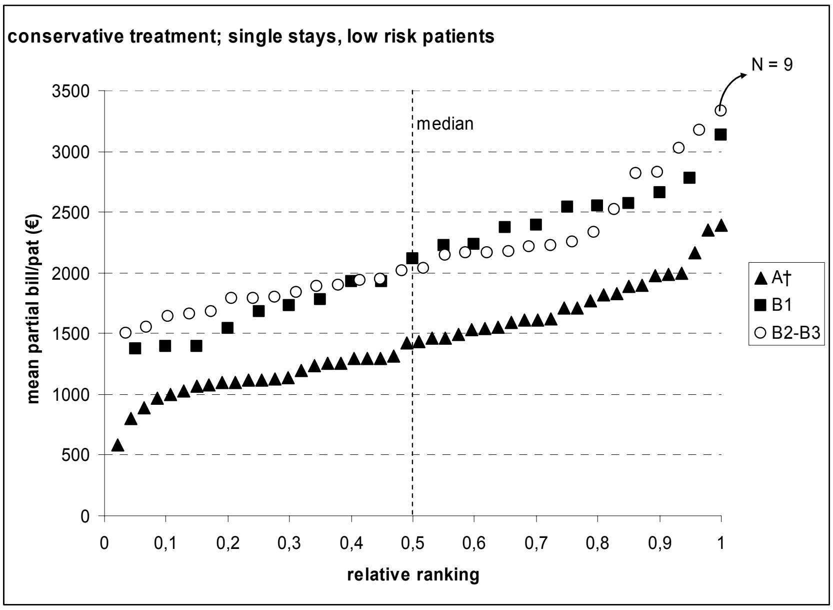
Figure 38: Mean Partial bill per Hospital (Single Stays Patients treated conservatively) (Low Risk Group)



Comparison between Conservative treatment and Thrombolysis only

Figure 39: Ranking of Hospitals following mean Partial bill of 7309 Single Stay Episodes (Thrombolysis only and Conservative treatment).





† 10 patients or more

Legends of Thrombolysis part of figure 39 show the number of hospitals with 10 patients or more. The Y-axis has been moved down for direct comparison.

The Figure 39 shows the partial bills (without costs of LOS) by CCF. B2-B3 hospitals may include patients which were referred by other hospitals, but all are at low risk. One B2-B3 hospital, the most expensive, treated only 9 patients conservatively. Thrombolysis was more rare, as the legends in the figure 39 show.

If the patients were a truly homogeneous group (now they are younger, without previous cardiovascular history, without diabetes and pump failure problems, and at low mortality), and treatment was standard, a small increase caused by random error would ensue. The figure shows that the span between cheaper and more expensive hospitals is large, indicating large variability in resource use. For the same conservative treatment in a low risk group of patients at good prognosis, the costs per patient (costs of LOS excluded) varied between 1000 € (the 10th percentile of the cheaper A hospitals) and 2660 €/2830€ (the 90th percentile of the B1/B2-B3 hospitals). For thrombolytic treatment in a low risk group of patients at good prognosis and younger age, the costs per patient (costs of LOS excluded) varied between 1500 € (the 10th percentile of the cheaper A hospitals) and 3500 €/3900€ (the 90th percentile of the B1/B2-B3 hospitals).

Cost before transfer.

While the previous sections focused on patient with a single stay episode of care, the purpose of the following section is to assess whether a difference exists in terms of costs between CCP A and B1 before transferring patients for invasive procedure. In the Low Risk Group, we considered the 4588 index admissions in A and B1 preceding a transfer to a B2-B3 hospital.

Table 30 gives the global results for the 4588 index distributed between A and B1 hospitals.

Table 30 : Partial and Total bill (€) and LOE (days) (Index Admission of Patients transferred afterwards to B2-B3 hospitals) (Low Risk Group)

CCP	N patients	Label	Mean	Median	Std Dev	Lower Quartile	Upper Quartile
A	3420	LOS index Partial bill index Total bill index	7.3 2382.0 3856.2	7.0 1818.3 3432.6	4.2 1854.9 2177.9	4.0 1126.6 2264.5	10.0 2865.3 4929.7
B1	1168	LOS index Partial bill index Total bill index	7.4 2508.1 4083.4	7.0 2175.5 3837.3	4.6 1524.4 1991.8	4.0 1548.5 2713.5	10.0 3077.4 5195.0

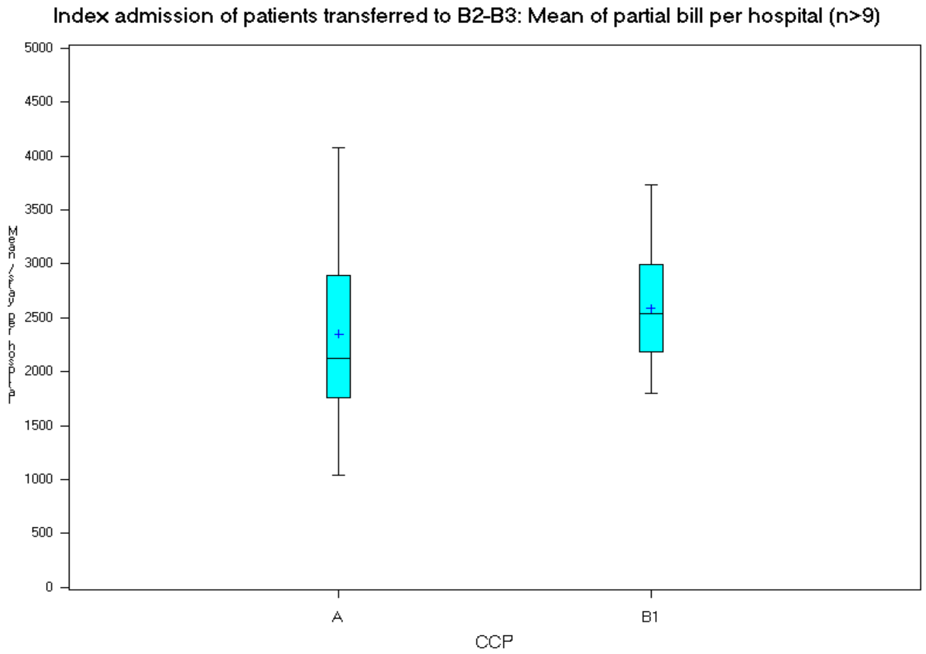
We could think that B1 hospitals costs are higher because of the possibility of doing a CAG. As explained before, some arrangements between hospitals lead do invoiced CAG's and PCI's on A hospitals bills and to PCI's on B1 hospitals. From 3420 patients who spent their index admissions in A hospitals, 3101 had no CAG invoiced during this stay, which represents 90.7%. This percentage is 84.9% (992 index admissions without CAG); hence, the bias due to the CAG possibility of Cardiac Care Program B1 was very limited. Again, A hospitals seem to be cheaper than B1 hospitals, with the same length of stay. We may see this also by looking at the distribution of bill mean per hospitals in both Cardiac Care Programs, on Table 31.

Table 31 : Partial and Total bill (€) per Hospital (Index Admissions of Patients transferred afterwards to B2-B3 hospitals (Low Risk Group)

			Partial bill					Total bill				
CCP	N hosp	N patients	Mean	Std dev	Median	Lower Quartile	Upper Quartile	Mean	Std dev	Median	Lower Quartile	Upper Quartile
A	72	3385	2349.9	747.8	2124.2	1756.0	2897.1	3808.0	855.1	3783.1	3067.2	4473.1
B1	19	1165	2584.5	509.3	2539.3	2187.8	2995.8	4202.0	685.8	4040.2	3702.3	4718.1
All	91	4550	2398.9	708.7	2328.1	1814.0	2932.1	3890.3	834.8	3856.6	3122.1	4537.4
Note: The mean partial and total bill have been computed for each hospital separately (with more than 10 stays). This table presents the distribution of these percentages, which allows to assess the inter hospital variability.												

The mean partial bill per hospital of index admission with at least 10 stays is given in Figure 40.

Figure 40: Mean Partial bill ( ) per Hospital (Index admissions of patients transferred afterwards to B2-B3 hospitals). (Low Risk Group)



Cost of Urgent and Late PCI

To evaluate the cost of a treatment by PCI, we took into account the single stay episodes with a PCI in B2-B3 hospitals. Stays with CABG were excluded. There are 2681 episodes from the Low Risk Group with a PCI, from which we kept 2655 episodes without CABG. 1066 patients (40.1%) underwent an urgent PCI on the day of their admission.

The mean partial bill for these episodes was € 6062 (median € 5837; Q1: €5038 Q3: € 6672). Hospital day cost included, this amounts to a mean of € 8499 (median € 8033; Q1: € 6874; Q3: € 9367) with a mean length of episode at 8.8 days (median: 8 days; Q1: 6 days; Q3: 10 days).

The variability of the cost of treatment involving a PCI in B2-B3 is relatively limited. This can be seen on Table 32 and Figure 41 that gives the distribution of mean partial bill, all hospitals treated at least 10 stays.

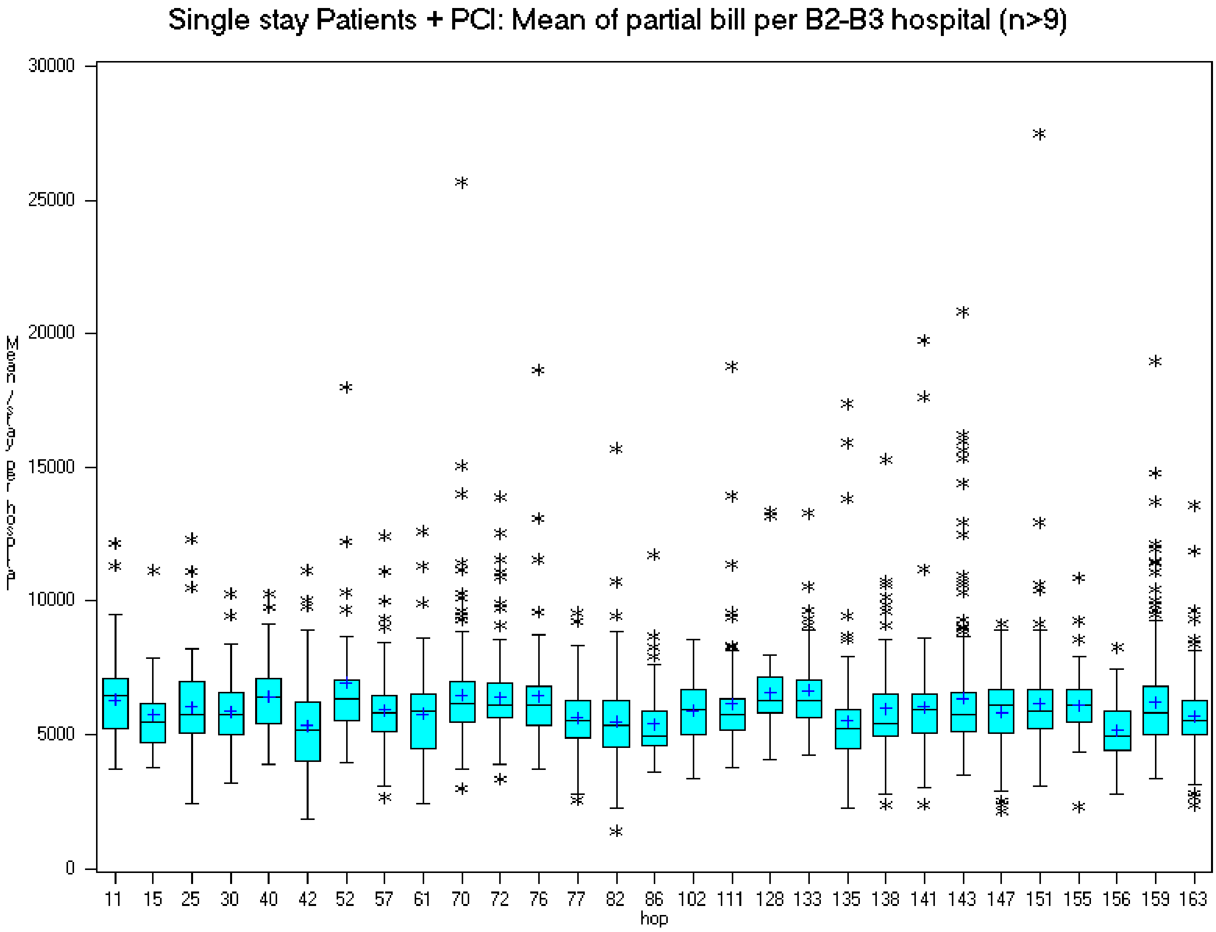
Table 32 and Figure 41 that gives the distribution of mean partial bill, all hospitals treated at least 10 stays.

Table 32: Mean partial bill per Hospital (€) (single stays in B2-B3). (Low Risk Group)

			Partial bill					Total bill				
CCP	Number of Hospitals	Number of index admissions	Mean	standard deviation	Median	Q1	Q3	Mean	standard deviation	Median	Q1	Q3
B2-B3	29	2655	6022.1	430.1	6038.2	5739.8	6370.7	8482.6	670.9	8466.8	7998.6	8838

Note: The mean partial and total bill have been computed for each hospital separately (with more than 10 stays). This table presents the distribution of these percentages, which allows to assess the inter hospital variability.

Figure 41: Mean Partial bill ( ) per B2-B3 Hospital (single stays). (Low Risk Group)



We compare if there was a cost difference between the patients treated with an urgent PCI and those treated with a late. 1066 patients (40.1%) underwent an urgent PCI on the day of their admission. There were no obvious cost differences, as shown in Table 33.

Table 33 : Partial and Total bill (€) and LOE (days) by type of PCI (Single stays in B2-B3 hospitals). (Low Risk Group)

PCI Timing	N patients	Variable	Mean	Std Dev	Median	Lower Quartile	Upper Quartile
Late	1589	Length of episode Partial bill episode Total bill episode	9.0 6042.1 8492.2	5.1 1796.7 2836.4	8.0 5822.7 8085.8	6.0 4951.3 6917.7	11.0 6760.3 9506.2
Urgent	1066	Length of episode Partial bill episode Total bill episode	8.5 6091.1 8509.0	7.9 1971.6 3603.1	8.0 5849.5 7945.4	6.0 5133.1 6822.9	10.0 6543.8 9119.3

Cost of CABG

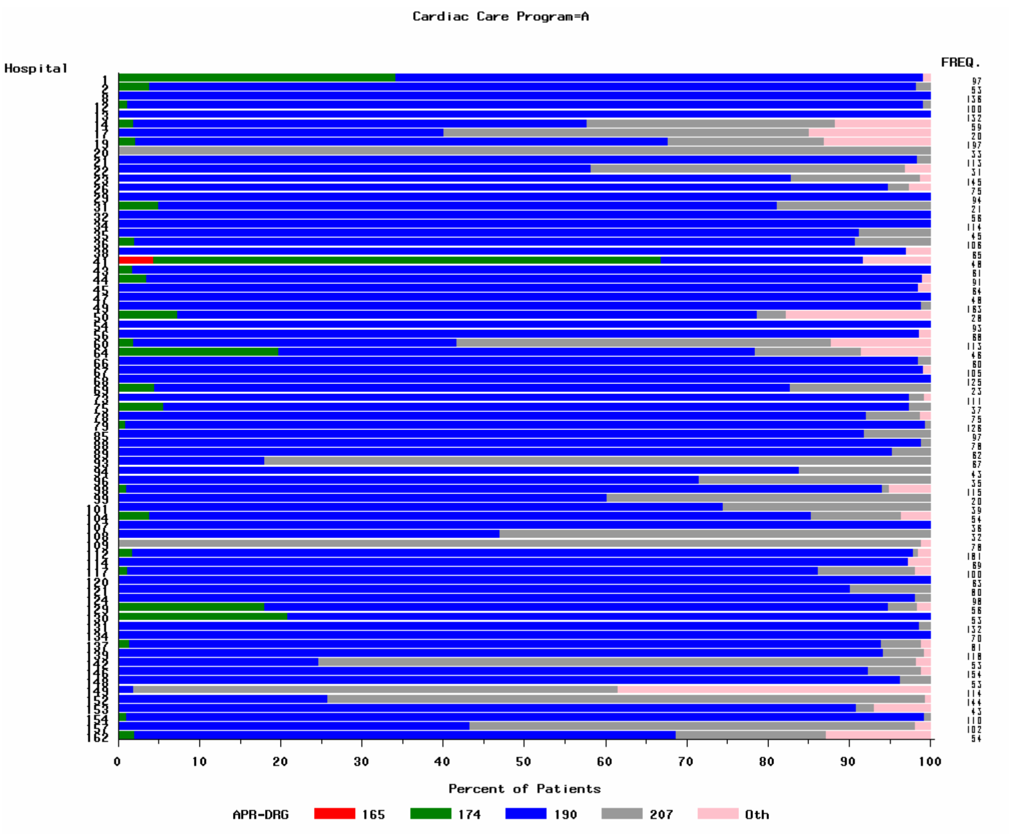
The cost of treatment by CABG was computed on patients from Low Risk Group who underwent a CABG but no PCI during their single stay in a B2-B3 hospital. Amongst 226 patients with a CABG received during their stay, 200 patients did not receive a PCI during this episode. As no patient received an urgent PCI, the timing of the CABG was not taken as an element of comparison. The mean partial bill for these whole episodes was € 9626 (median € 9351; Q1: €8379; Q3: € 10364). Hospital day cost included, this amounts to a mean of € 15105 (median € 14621; Q1: € 12697; Q3: € 10364) with a mean length of episode at 20.2 days (median: 19 days; Q1: 14 days; Q3: 23 days). The mean bill per hospital was not calculated as there were only 5 hospitals with at least 10 single stays + CABG.

4.2.7. Variability in Coding Between Hospitals

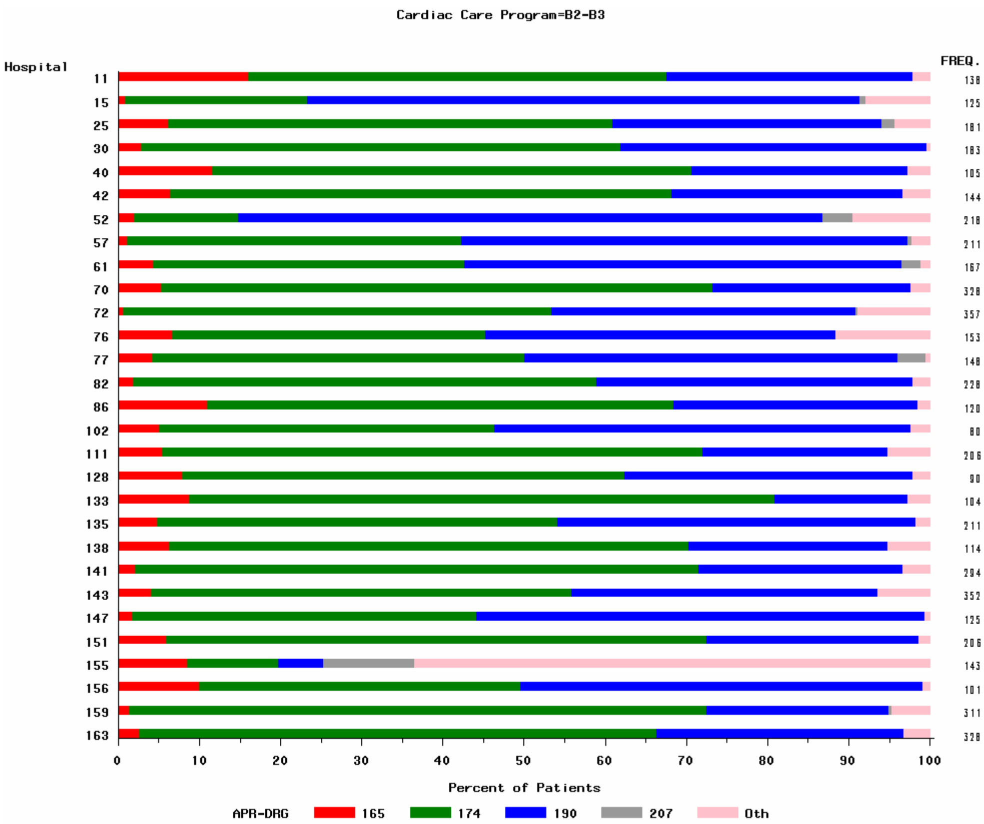
APR DRG of Index Admission

Figure 42 presents the APR-DRG of the index admission stay (first stay in episode of care) for patients included in the Low Risk Group, with a first admission in an A, B1 or B2-B3 hospital, by hospital of admission. In A or B1 hospitals, the majority of stays belongs to the APR-DRG 190 (circulatory disorders with AMI). For some A and B1 hospitals, the majority of first stays belongs to the APR DRG 207 (other circulatory disorders). The stays in the APR-DRG 174 (percutaneous cardiovascular procedures with AMI), 191 (cardiac catheterization with circulatory disorder except ischemic heart disease) are distributed across a few A or B1 hospitals. For the B2-B3 hospitals, the majority of index admissions belong to the APR-DRG 174, 190 and 165 (coronary bypass without malfunctioning, with cardiac catheterization). A few hospitals have a different pattern.

Figure 42 : Distribution of the APR DRG of Index Admission (Low Risk Group)




Cardiac Care Program=B1
Hospital
FREQ.
5 248
28 91
48 71
53 76
59 99
71 137
95 86
97 118
105 66
106 129
115 160
116 118
119 211
126 175
127 68
144 139
145 93
150 113
161 168
164 86
0 10 20 30 40 50 60 70 80 90 100
Percent of Patients
APR-DRG 174 190 207 Oth


Cardiac Care Program=B2-B3
Hospital
FREQ.
11 138
15 125
25 181
30 183
40 105
42 144
52 218
57 211
61 167
70 328
72 357
76 153
77 148
82 228
86 120
102 80
111 206
128 90
133 104
135 211
138 114
141 294
143 352
147 125
151 206
155 143
156 101
159 311
163 328
0 10 20 30 40 50 60 70 80 90 100
Percent of Patients
APR-DRG 165 174 190 207 Oth

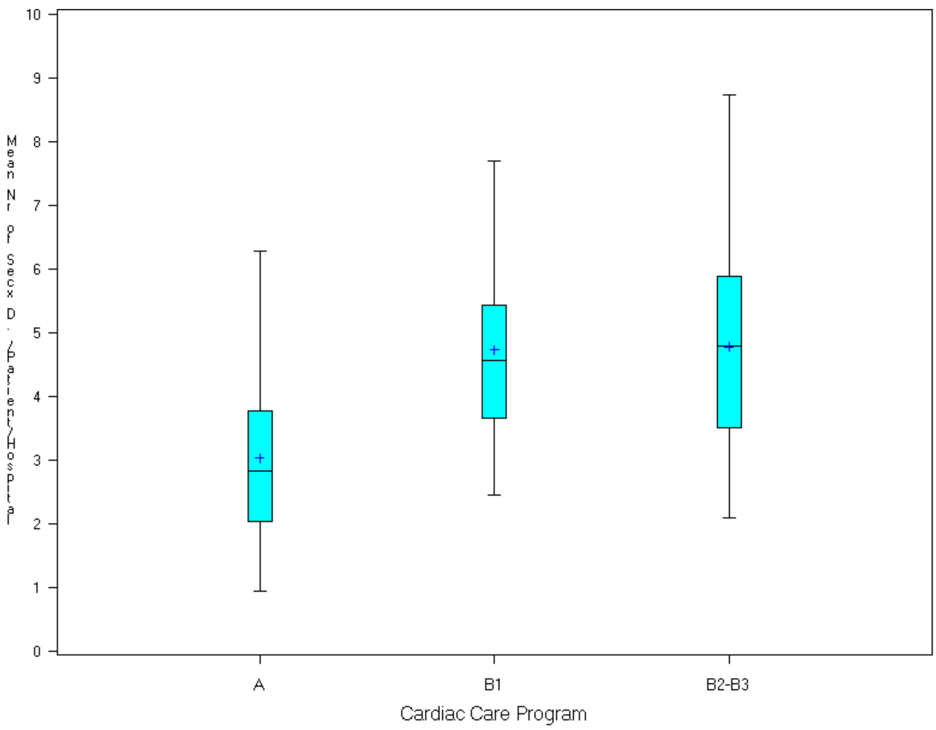
Number of Secondary Diagnoses of Index Admission

The average number of secondary diagnoses per patient is 3.9 (from the index admission), for patients in the Low Risk Group. The number of secondary diagnoses is slightly lower in CCP A than in CCP B1 and B2-B3. Table 34 presents summary statistics by patient, and Figure 43 presents summary statistics by hospital (the average number of secondary diagnoses ranges from 1 per patient in some hospitals to 9 per patient in others).

Table 34 : Average Number of Secondary Diagnoses of index Admission, by CCP of Index Admission (Low Risk Group)

CCP	N	Mean	Std Dev	Median	Minimum	Lower Quartile	Upper Quartile	Maximum
A	5945	3.0	2.5	3.0	0.0	1.0	4.0	23.0
B1	2452	4.7	3.2	4.0	0.0	2.0	6.0	30.0
B2-B3	5471	4.6	3.4	4.0	0.0	2.0	6.0	29.0
Total	13868	3.9	3.1	3.0	0.0	2.0	5.0	30.0

Figure 43: Average Number of Secondary Diagnoses per Patient, per Hospital of Index Admission (Low Risk Group)



4.3. MORTALITY AFTER ACUTE MYOCARDIAL INFARCTION (ALL PATIENTS)

4.3.1. Short Term and Long Term Mortality by Gender, Age and Residence

Overall results on short term and long term mortality after the acute myocardial infarction are presented in this section. Table 35 presents mortality results for the whole population of patients, and by gender. The same results are displayed graphically by age and gender in Figure 44.

The overall short term mortality, defined as death during the month of admission or the month after (Month 0/1), is 15.5% (12.2% for male, 22.1% for female patients). The in-hospital mortality (during the episode of care) is very similar (15.0%). 5.2% of the patients deceased at Day 1. Two years after the myocardial infarction, more than a quarter of the patients had died (26.1% in total, 21.2% male, 35.8% female).

Table 35 : Overall Mortality Results for All Patients and by Gender

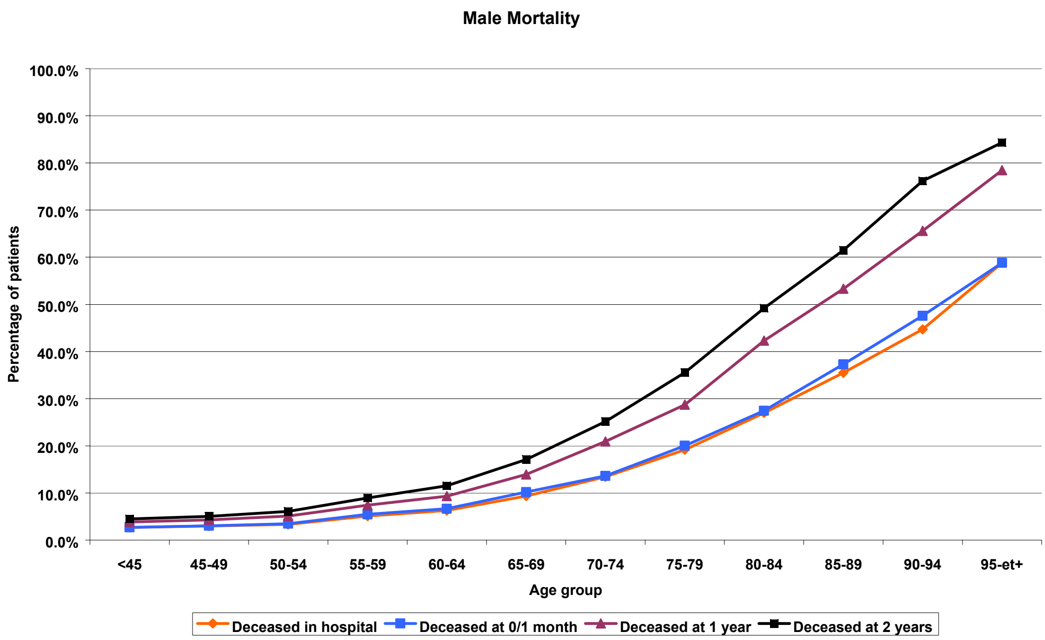
Mortality	% Death Male	% Death Female	% Death All Patients
Number of Patients	23216	11745	34961
Mean Age (SD)	64.7 (13.0)	73.9 (12.5)	67.8 (13.6)
Death at Day 1	4.1	7.4	5.2
Death during First Hospital Stay	10.4	19.7	13.6
Death during Episode of Care (Hospitalization)	11.7	21.5	15.0
Death during Month 0/1	12.2	22.1	15.5
Death after Year 1	17.7	30.9	22.1
Death after Year 2	21.2	35.8	26.1

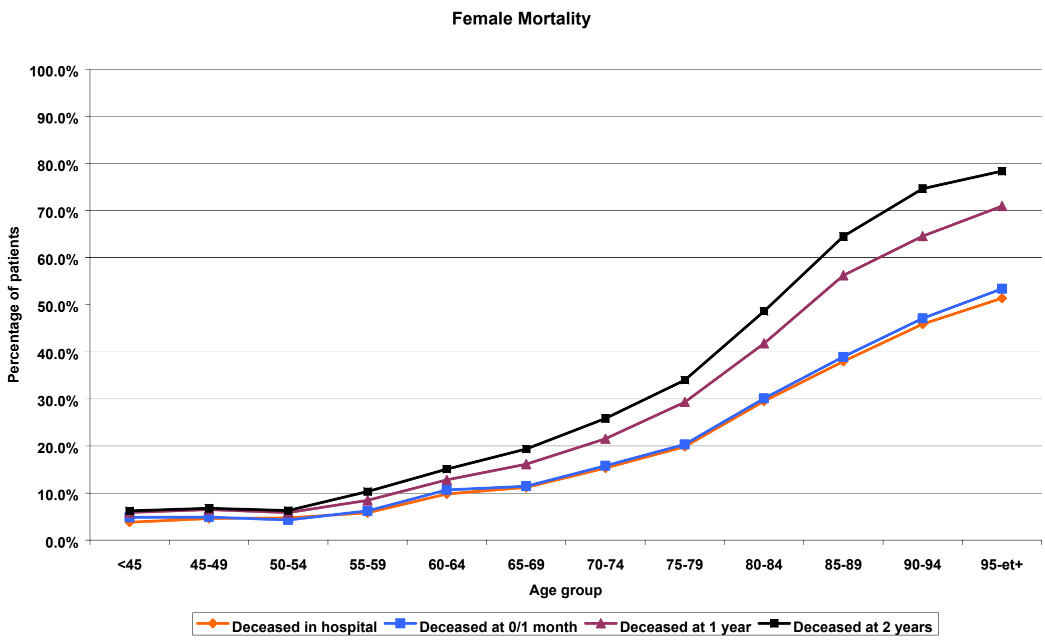
Age, gender, history of diabetes and history of cardiovascular disease have a strong influence on short term mortality, as presented later below in Table 41 (descriptive results). Results from logistic regression show that the risk of death (as measured by the odds of death) increases by 113% when the age increases by 10 years, is 12% higher for women than for men, is 22% higher for patients with a cardiovascular history, and 23% higher for patients with diabetes.

Table 36: Results from Logistic Regression on Short Term Mortality (Odds ratio and 95% CI)

Effect	Odds Ratio	(95% CI)	
Age (increase of 10 years)	2.13	(2.06,	2.19)
Gender (Female vs Male)	1.12	(1.05,	1.19)
Cardiovascular History (Yes vs No)	1.22	(1.14,	1.31)
Diabetes (Yes vs No)	1.23	(1.15,	1.31)

Figure 44: Overall Mortality Results by Gender and Age Category





Figures 45 and 46 show the short term mortality and one year mortality for all AMI patients, standardized by Age and sex. Appendix G1 shows the same results for Low Risk Group including death at the end of Episode.

Figure 45: Short Term Mortality (Month 0/1) by District of Residence, Standardized by Age and Sex (Number of Deaths for 100 000 inhabitants)

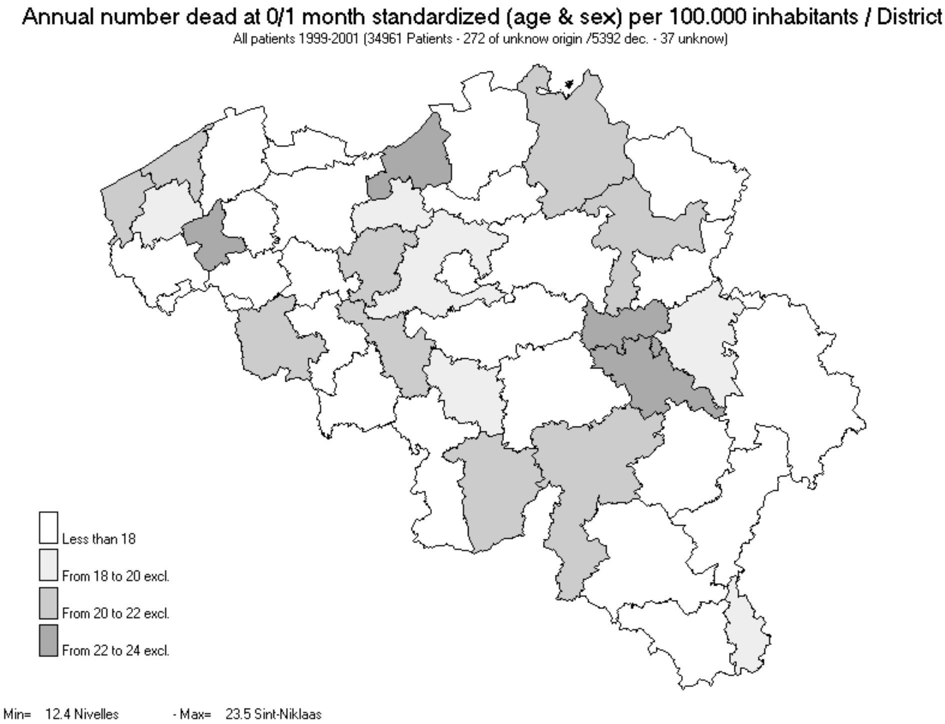
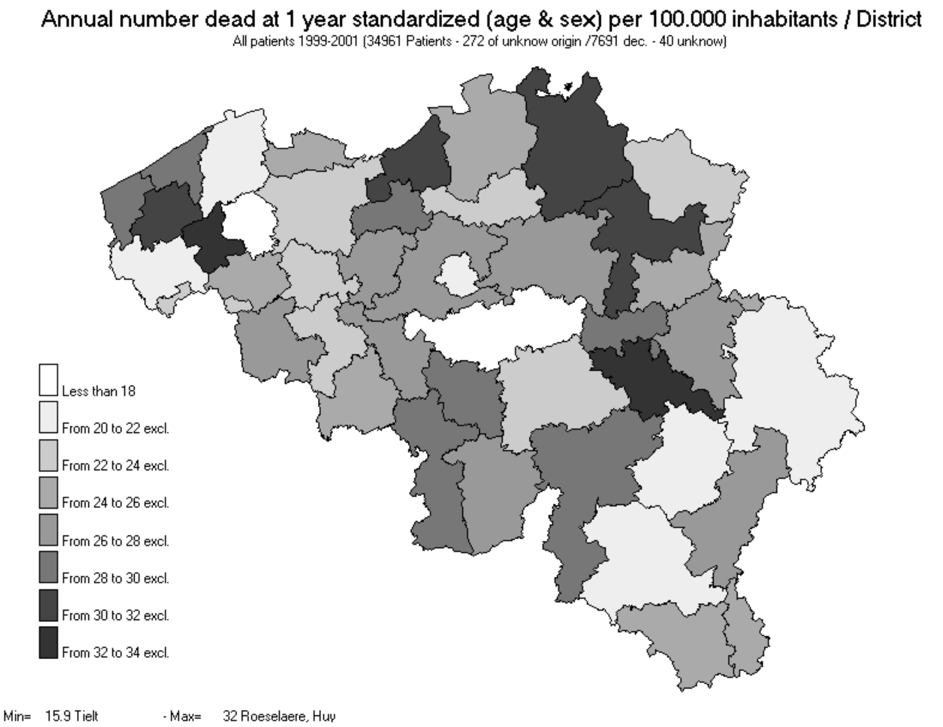


Figure 46: One Year Mortality by District of Residence, Standardized by Age and Sex (Number of Deaths for 100 000 inhabitants)



The influence of baseline demographics characteristics on long term mortality data is presented below. Mortality data, provided by the health insurers, were available until the end of the year 2003, implying that for patients admitted early 1999, almost 5 years of follow up was available. For all patients, a complete follow up of 2 years was available. Patients still alive at the end of 2003 were censored in the survival analyses presented below.

The survival function over 5 years is presented in Figure 47 (Life Table estimator), for all patients and also stratified by age group (<= 65 years, > 65 years) and sex. Results are also presented in Table 37 for all patients. The overall survival probability after 1 year was 78%, after 2 years 74%, and decreased to 63% after 5 years.

Figure 47: Survival Function (Life Table Estimate) over 5 years All Patients and Stratified for Age Group and Sex

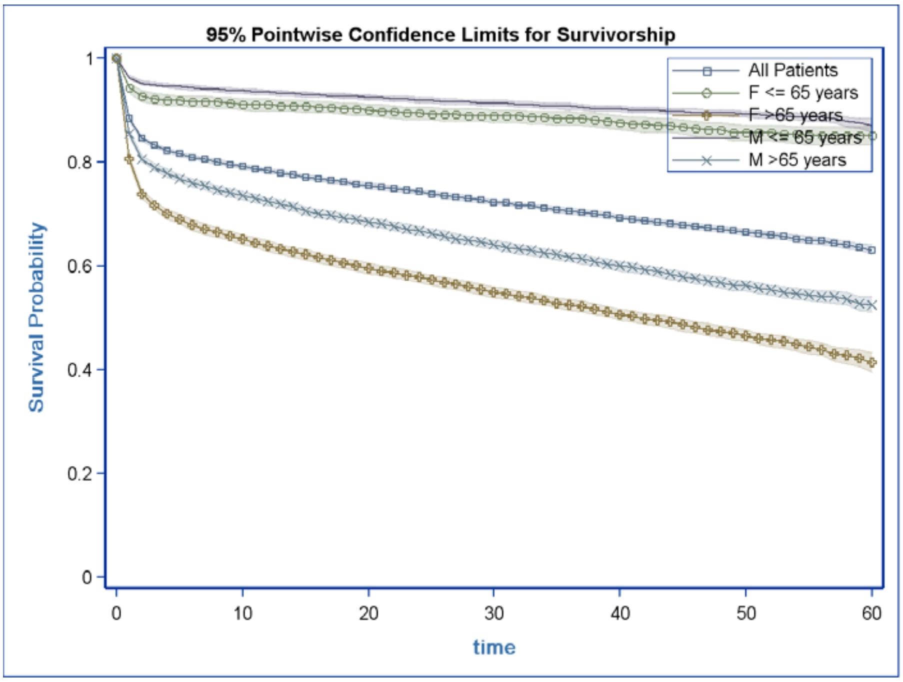


Table 37: Survival Function (Life Table Estimator) - All Patients (Complete Table in Appendix G2)

Year	Months Interval		Sample Size	N Failed	N Censored	Survival	Failure	Survival SE
0	0	3	34961.0	5878	0	1.00	0.00	0.0000
1	12	15	27367.0	401	0	0.78	0.22	0.0022
2	24	27	24922.0	343	2058	0.74	0.26	0.0023
3	36	39	15440.5	205	2107	0.71	0.29	0.0025
4	48	51	6912.0	88	1894	0.67	0.33	0.0028
5	60	.	84.5	0	169	0.63	0.37	0.0041

N failed: number of patients who died during the time interval
N censored: number of patients censored during the time interval (patients lost to follow up)

Table 38 presents the results from the Cox PH model (applied on data grouped per 3 months time interval). Age, cardiovascular history and diabetes have a strong influence on the survival function. The observed difference in mortality over 5 years between males and females disappears after adjusting for other risk factors (age, cardiovascular and diabetes).

Table 38: Results from Cox PH Model (Hazard Ratio and 95% CI) (data grouped per 3 month interval) All Patients

Label	Hazard Ratio	(95% CI.)	
Age (increase of 10 years)	2.15	(2.11,	2.20)
Gender (Female vs M)	1.00	(0.96,	1.04)
Cardiovascular History (Yes vs No)	1.42	(1.36,	1.48)
Diabetes (Yes vs No)	1.42	(1.37,	1.48)

4.3.2. Influence of Cardiac Care Program of Index Admission

Table 37 presents short term and long term mortality results by cardiac care program of index admission. Observed short term mortality percentages are respectively 16.5, 15.7 and 14.4% for patients first admitted to A, B1 or B2-B3 hospitals. Results from logistic regression are presented in

Table 40, and show that, after adjustment for age, sex, cardiovascular history and diabetes, there is no significant difference between the 3 CCP of admissions on short term mortality.

Table 39 presents the short term mortality rates by CCP of index admission and by patient's baseline characteristic

Table 39 : Short Term Mortality for All Patients, by Cardiac Care Program of Index Admission

	CCP of Index Admission			
	A	B1	B2-B3	All Patients
Number of Patients	15205	6367	13389	34961
Death at Day 1 (%)	5.8	5.2	4.6	5.2
Death during First Stay (%)	14.1	13.8	12.9	13.6
Death during Episode of Care (Hospitalization) (%)	15.8	15.3	14.0	15.0
Death during Month 0/1 (%)	16.5	15.7	14.4	15.5
Death at Year 1 (%)	23.1	22.3	20.8	22.1
Death at Year 2 (%)	27.3	26.4	24.6	26.1

Table 40 : Results from Logistic Regression on Short Term Mortality (Odds Ratio and 95% CI), Comparison of CCP of Index Admission, (with GEE Correction for Clustering of Patients)

CCP Comparison	Odds Ratio	(95% CI)	
CCP A vs CCP B2-B3	1.05	(0.93,	1.19)
CCP B1 vs CCP B2-B3	1.03	(0.89,	1.19)
CCP A vs CCP B1	1.02	(0.90,	1.15)

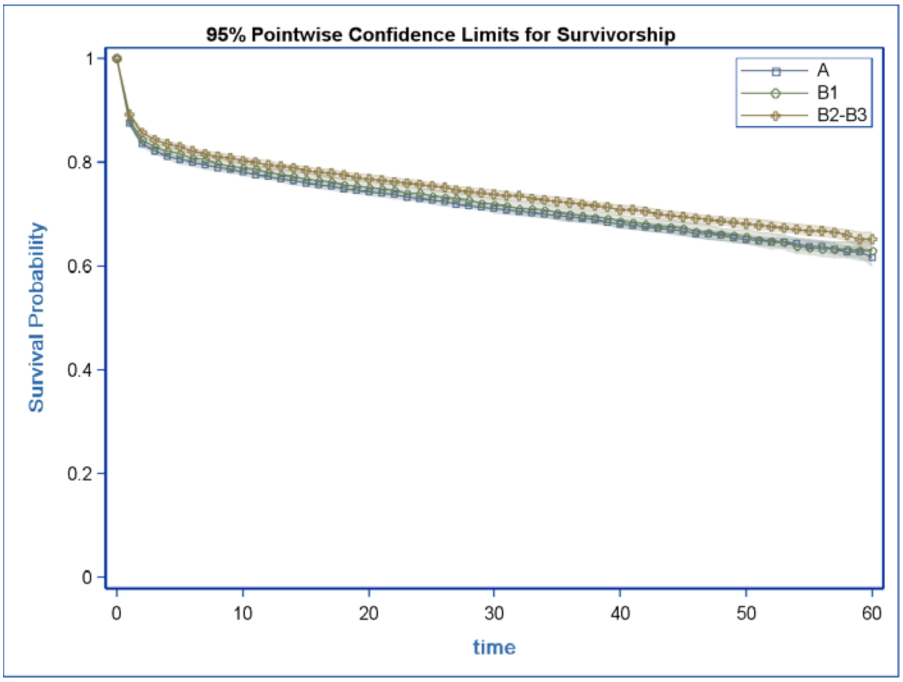
Note: these comparisons are adjusted for age, sex, cardiovascular history and diabetes.

Table 41 : Short Term Mortality for All Patients by Baseline Characteristics and CCP of Index Admission

		CCP of Index Admission						All Patients	
		A		B1		B2-B3		Total	
category		N	% death	N	% death	N	%	N	% death
Total		15205	16.5	6367	15.7	13389	14.4	34961	15.5
Discharge year	1999	5284	16.6	2066	15.8	4076	14.3	11426	15.6
	2000	5009	16.9	2135	16.1	4514	15.0	11658	16.0
	2001	4912	15.9	2166	15.2	4799	13.9	11877	14.9
Age Category	0 -49 years	1439	3.8	735	2.7	1737	2.9	3911	3.2
	50-59 years	2334	4.3	1036	4.8	2351	4.8	5721	4.6
	60-69 years	3537	9.2	1385	8.3	3102	9.8	8024	9.3
	70-79 years	4565	18.1	1893	16.6	3807	16.8	10265	17.4
	80-89 years	2726	33.6	1100	34.6	1982	31.3	5808	33.0
	> 90 years	604	46.4	218	54.6	410	48.3	1232	48.5
Gender	Female	5204	23.5	2225	22.2	4316	20.3	11745	22.1
	Male	10001	12.8	4142	12.2	9073	11.6	23216	12.2
Cardiovascular History	No	12252	15.1	5098	14.1	10526	13.2	27876	14.2
	Yes	2953	22.2	1269	22.0	2863	18.8	7085	20.8
Diabetes	No	11504	15.3	4714	14.9	10064	12.9	26282	14.3
	Yes	3701	20.2	1653	18.1	3325	18.7	8679	19.2
Secondary Diagnoses	<= 4	9902	15.0	2749	14.9	6310	13.9	18961	14.6
	> 4	5303	19.1	3618	16.3	7079	14.8	16000	16.6

Survival Function (Life Table Estimator) stratified by the CCP of first index admission is presented in Figure 48.

Figure 48 Survival Function (Life Table Estimate) over 5 years by Cardiac Care Program of Index Admission



Results from Cox PH regression are presented in Table 42. After adjustment for age, sex, cardiovascular history and diabetes, the Cardiac Care Program of the index admission has no significant influence on the survival curve.

Table 42: Results from Cox PH Model, Comparison of CCP of Index Admission (data grouped per 3 month interval) - All Patients

CCP Comparison	Hazard ratio	(95% CI)	
CCP A vs CCP B2-B3	1.01	(0.97,	1.06)
CCP B1 vs CCP B2-B3	1.03	(0.98,	1.09)
CCP A vs CCP B1	0.98	(0.93,	1.03)
Note: these comparisons are adjusted for age, sex, cardiovascular history and diabetes			

4.3.3. Influence of Treatment Received

To assess whether the different forms of AMI management (conservative therapy, reperfusion, revascularization) have an effect on mortality, and to quantify this effect, an approach would be to compare the outcome between the different groups of patients. This is an obvious approach in randomized design, as the randomization ensures that (on average) observed and non observed patient characteristics are identical between the groups, the only factor differing between them being the treatment. In observational study the story is completely different, as there is no control over the treatment assignment to subjects. The decision to give a patient a certain treatment depends on a combination of complex factors, including the comorbid diseases, the severity and type of AMI and other clinical factors, as well as the physician's preference. The result of this lack of control on treatment assignment is that patients receiving different treatments will be different before they receive the treatment (a phenomenon called selection bias), hence introducing bias in the treatment comparisons. Standard statistical methods, such as regression and propensity scores, can be used to adjust for the differences that are observed (but obviously not for the differences in the baseline characteristics that are not observed). Propensity scores methods compute, for each patient, the probability that this patient is treated, given all his covariates (baseline characteristics). If enough of the covariates that are believed to be related to the treatment assignment are observed, then approximately unbiased estimates can be obtained. [51]]. The major drawback of the administrative data is the lack of clinical information on the AMI (severity, Killip class, STEMI, NSTEMI), etc …), all clinical characteristics that do have an influence the choice of treatment assignment. Therefore, only descriptive are presented below in Table 43, and caution is needed in the interpretation of the results.

Table 43 : Short Term Mortality (Month 0/1) by Type of Treatment Received

Treatment	N patients	Mean Age	% Death
All Patients	34961	67.8	15.5
Reperfusion	12765	64.1	10.9
Thrombolysis	10021	64.8	11.7
PCI/CABG Urgent	2372	61.1	8.2
Thrombolysis +PCI or CABG urgent	372	61.6	5.9
Revascularization	14226	62.6	3.8
PCI	11525	62.0	3.8
CABG	2537	65.4	3.3
PCI + CABG	164	63.5	5.5
Conservative Therapy	15161	72.9	25.1
Note : A patient is counted only once in a subgroup category (for example, a patient with thrombolysis and urgent therapy is counted only in the category “Thrombolysis +PCI or CABG urgent”)			

4.3.4. Influence of Use of Resource in Hospital

In this crude analysis, we tested the hypothesis if a higher use of resources lead to better outcomes. We divided the hospitals per care program in three groups: high users (hospitals in the upper quart of the distribution), low users (hospitals in the lower quart) and medium users (the other half of the hospitals), based on their average consumption per patient in the index admission, single stays only, low risk group only. We used the total bill per patient. Note that these are hospital characteristics, not patient characteristics.

The zero hypothesis should be read as "patient first arriving in a more expensive hospital have an equal prognosis compared to patients first arriving in a cheaper hospital". That zero hypothesis stood up to the test (see table). There was no indication that more was better. The table shows that, after adjustment for patient’s age, gender, cardiovascular history and diabetes, there is no difference in outcomes between the low, medium and high users hospitals.. These results give additional support to the hypothesis that, conditional on admission in a A, B1 or B2 hospital, an increased use of resources does not cause a better outcome. Which an average of more than 1000 €/patient difference between high users and low users, there is room for a considerable improvement in a more economic use of resources.

Table 44 : Influence of Hospital Cost Category on Short Term and Long Term Mortality

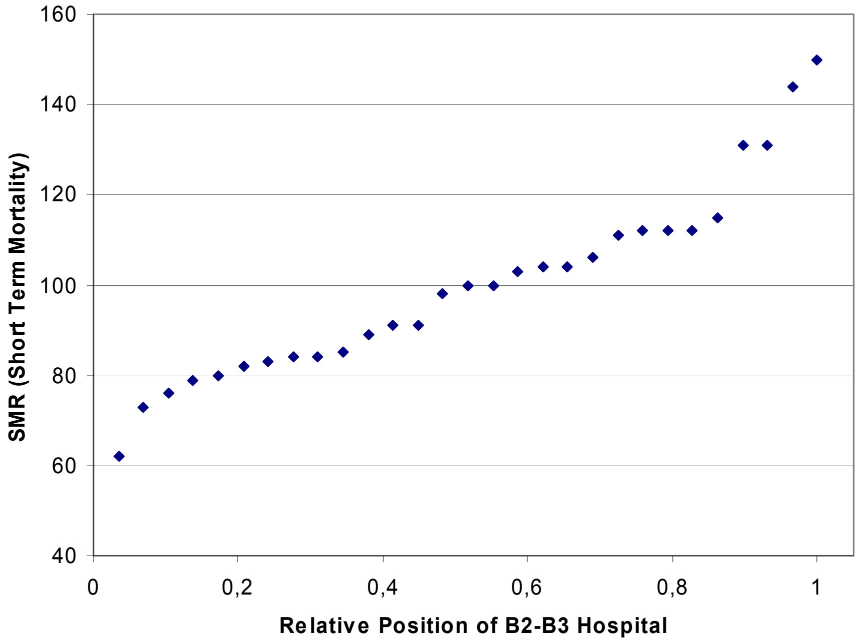
	CCP of Index Admission		
	A	B1	B2-B3
Cost Limits (Q1 and Q3 of Cost Distribution)			
Q1 = limit between Low and Medium User	3476	4340	7298
Q3 = limit between Medium and High User	4467	5769	8211
Short Term Mortality (Observed)			
Low User Hospital	15.8	16.4	12.6
Medium User Hospital	16.6	15.4	15.2
High User Hospital	16.8	15.5	14.5
Short Term Mortality (Odds Ratio and 95% CI)			
Low versus High User	0.90 (0.72, 1.11)	0.90 (0.72, 1.13)	0.92 (0.75, 1.13)
Medium versus High User	0.96 (0.80, 1.16)	0.92 (0.75, 1.14)	1.11 (0.88, 1.40)
Low versus Medium User	0.93 (0.79, 1.10)	0.98 (0.76, 1.25)	0.83 (0.68, 1.01)
Long Term Mortality (Hazard Ratio and 95% CI)			
Low versus High User	0.91 (0.80, 1.04)	1.00 (0.88, 1.13)	0.95 (0.84, 1.06)
Medium versus High User	0.96 (0.85, 1.09)	1.04 (0.93, 1.16)	1.03 (0.91, 1.16)
Low versus Medium User	0.95 (0.86, 1.04)	0.96 (0.84, 1.11)	0.92 (0.82, 1.03)
Note: all comparisons have been adjusted for patients age, gender, cardiovascular history and diabetes			

4.3.5. Inter Hospital Variability

The variability in outcome (short term mortality) between hospitals is briefly described on the population of patients who were first admitted to one of the 29 B2-B3 hospitals (a total of 13 389 patients), as the transfer policy of patients first admitted to A or B1 hospitals greatly complicates the situation (a patient is treated by more than 1 hospital, so it is difficult to assess what is the influence of the specific hospitals on the outcome).

For patients first admitted to B2-B3 hospitals, the overall short term mortality is 14.4%. Within each hospital, the observed short term mortality ranges from 7.7% to 24.6%. After adjustment for age, sex, cardiovascular history and diabetes, the Standardized Mortality Ratios SMR (in each hospital, the observed number of deaths divided by the expected number of deaths) ranges from 62% to 150% and is presented in Figure 49. Other important clinical factors that influence the outcome, but that are not available in the administrative database, are needed before any conclusions can be drawn on the differences in outcomes between the hospitals.

Figure 49: SMR on Short Term Mortality for Index Admissions in B2-B3 Hospitals



5. GENERAL CONCLUSIONS & DISCUSSION

5.1. INTRODUCTION

Remarkably little reliable data are available about the routine management of ACS. Much of the existing data originate from clinical trials or are in other ways restricted to selected patients that do not represent the population. Furthermore, it is difficult to compare populations of clinical trials as inclusion criteria and definitions vary from one study to the other.

Both the GRACE registry[52] and the Euro Heart Survey on ACS[8] (EHS) are often referred to in this report because these registries consider comparable populations to ours. The GRACE registry is a multinational, prospective, observational study of clinical management practices and patient outcomes across the full spectrum of ACS. Hospitals located in 14 countries in North and South America, Europe, Australia and New Zealand have contributed data. Six Belgian hospitals are taking part in this global registry: Brugge, Aalst, Leuven, Seraing, Charleroi, and Brussels (Erasme).

The Euro Heart Survey on ACS is a research project conducted by the European Society of Cardiology (ESC), instituted to delineate characteristics, treatments and outcomes of ACS throughout the member countries in Europe and the Mediterranean basin. Belgian participating centres are Liège and Yvoir.

As mentioned before, any interpretation has to take into account that we do not know the proportion of STEMI or NSTEMI in our population. The high rate of thrombolytic use and mortality suggest that STEMI's dominate. However, NSTEMI are not misclassified as ICD-9 411 ("Other acute and subacute forms of ischemic heart disease"). Only few patients coded as ICD-9 code 411 were grouped as AMI (APR-DRG 190).

Coupled hospital MCD/MFD data constituted the materials. Records identified by a unique (anonymised and unbreakable) patient code contain individual clinical and financial patient histories. Clinical data are relevant clinical ICD9-CM codes, registered at every discharge in a Belgian hospital and financial data contain billings reimbursed by health insurance. These patient histories more reflect real life medical practice and permit detailed analysis of variability in diagnostics, treatment, costs and outcomes between cardiac care programs. Patient mortality was followed up till a minimum of two years after the index admission through the billing system.

The MCD/MFD data have several limitations. These data are only available after several years, limiting their utility for current policy questions. Nevertheless, the past informs the future. The validity and quality of the data is uncertain and likely variable. Key clinical parameters predicting disease severity and prognosis are not available, limiting the possibility to adjust for confounding case mix. However, our interpretation is limited to grouped characteristics and does not describe individual clinical practices. It is unlikely that more detailed data of higher quality would change conclusions considerably: the high variability and high use of diagnostic techniques with limited utility is factual. There are no ascertainable differences in outcomes between patients admitted in different care programs. Confounding by identified characteristics of differences in case mix was minor (age, sex, previous history of disease, diabetes), which makes severe confounding by unidentified characteristics unlikely. To explain a relevant bias in our estimates, large differences in prevalence of unidentified characteristics with serious prognostic consequences are needed.

To assess treatment variability, we identified a sufficiently homogeneous patient group, identifiable by a low risk of mortality, complications and relapse. From a clinician's vantage point, feedback on a clinically identifiable group of patients informs practice more than on a far more heterogeneous patient group such as a APR-DRG. The selected patient group allowed a comparison unlikely to be biased between medical practices in low risk patients in different hospitals and different cardiac care facilities (cardiac care programs).

5.2. USE OF DIAGNOSTICS

5.2.1. Non-invasive diagnostics

The use of tests such as rest- and stress-ECG, ECG-monitoring, certain biochemical tests, chest X-ray and echocardiography is self-evident in the setting of an AMI, although we noticed a wide range of variability in their use, even in the homogeneous Low Risk Group. While such variability may be explained by 'random noise' in complex systems of patients, hospitals, regions and secular trends, the frequent use of outright obsolete tests of unidentified clinical utility can not be explained by random error, only by poor practice. Vectorcardiography, a now abolished practice, was performed in more than 20% of patients during the index admission. The appropriateness of some diagnostic investigations is often questionable. 25% of low-risk patients were offered pulmonary function testing during their index admission, one hospital performed more than 3 pulmonary function tests per patient on average. Lung function testing can be useful prior to open cardiac surgery, but adds little to a competent clinical examination outside this indication. Duplex ultrasound of the carotid arteries knows the same narrow indication but was executed in 20% of low risk patients.

In the Low Risk Group, a low use of rarely indicated testing is expected, but a too high use is observed, not to be explained by good medical practice guidelines. Overuse of such technology with rare indications was very variable between hospitals, indicating the validity of our assumption that use was often inappropriate. However, further examination revealed a consistent pattern of systematic high use in the intermediate level of cardiac care facility B1. 16/44 (36%) of the A hospitals and 10/29 (34%) of the B2-B3 hospitals performed more than two tests with dubious utility per patient, 14/20 (70%) of the B1 did so. Unexplained high use is a policy characteristic of the intermediate B1 level. The similar distribution of A and B2-B3 hospitals in the use of this diagnostic technology indicate that the level and referral function of cardiac care programs is unlikely to play a major role in the high use of rarely indicated technology.

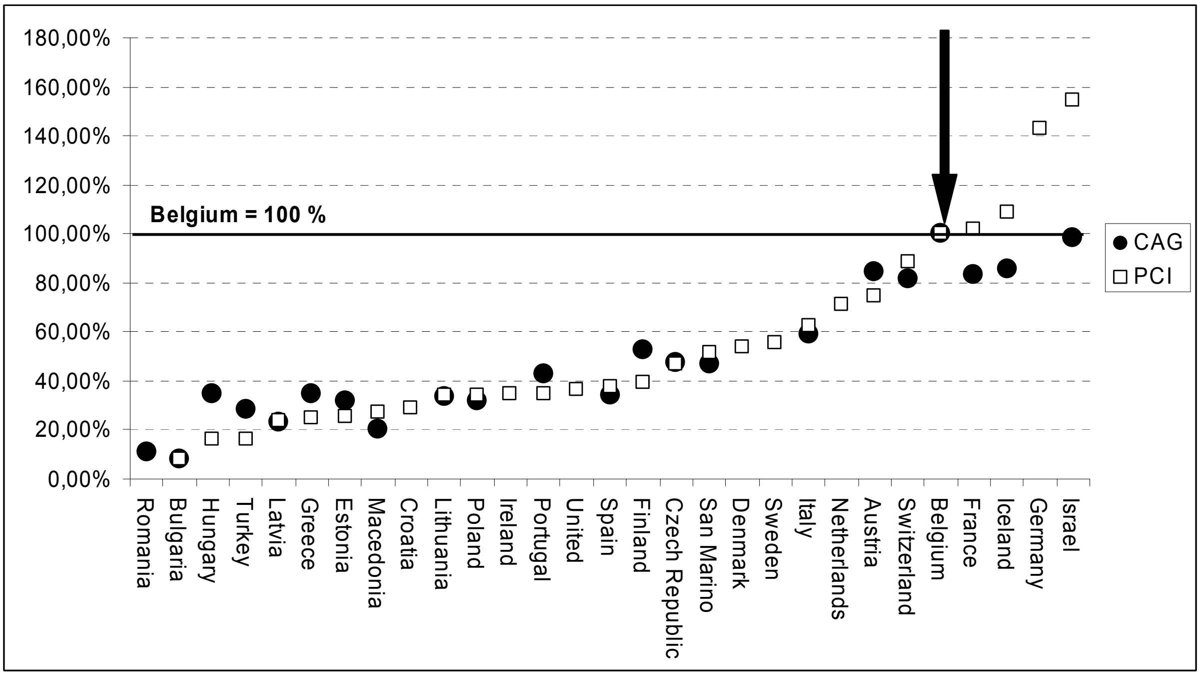
5.2.2. Elective Coronary Angiography

In a cost-effectiveness study on routine CAG after AMI, Kuntz et al[53] found that incremental cost-effectiveness ratios (ICER) for coronary angiography and treatment guided by its result, compared with initial medical therapy without angiography, ranged between $17 000 and > $1 million per quality-adjusted year of life (QALY) gained. These figures suggests that routine CAG following AMI is not warranted. Some patients subgroups in their study, especially those with severe postinfarction angina or a strongly positive exercise test and some subgroups with a prior MI had ICERs below 50000 $/QALY.

In both GRACE and EHS, a CAG was performed in approximately one-half of the survey cohort during the initial hospitalization. In this KCE report, the corresponding figure was 46 % during the episode and the Belgian practice conforms to average European practice. However, in the EHS, when the attending physicians were asked why CAG had been performed in their patients, in up to a third of cases the response was that it was routine policy. CAG in asymptomatic patients at low risk and without residual ischemia is little effective and should be avoided. Further refinement of the guidelines, taking into account cost effectiveness is advisable.

Of 2692 patients, 1683 (61%) underwent a control CAG following an urgent PCI and 86% of these patients were treated conservatively following that control angiogram. Routine CAG after a successful PCI is not mandatory[18].

According to the European Society of Cardiology, Belgium has the highest rates of overall usage of CAG of 22 European countries with data (see chart). The majority of CAGs are performed for patients with angina and less for AMI.



This chart from the ESC shows the relative position of Belgium (= 100%) in rates of CAG and PCI. Belgium is nr 1 in numbers of CAG and number 5 in numbers of PCI.[46]

Invasive coronary angiography is currently the diagnostic imaging standard for the evaluation of coronary artery disease. Multi-slice computed tomography (MSCT) of the coronary arteries is a new and still experimental technology that can identify the presence of coronary artery disease.[54] [55] [56] The resolution of this imaging modality is steadily increasing. Currently, the potential diagnostic value of MSCT in guiding preventive and therapeutic strategies is still unclear. However, this non-invasive and less expensive technique has the potential to replace invasive coronary angiography for patients after an ACS and can even be used easily in (asymptomatic) patients at risk. If this technique, proves its added value, it is bound to have a widespread dissemination in a large number of hospitals and it can be expected to have a major impact on the organisation of cardiac interventional care for several indications. A health technology assessment of this emerging technology is needed in the future.

5.3. MANAGEMENT OF AMI

5.3.1. Use of secondary prevention strategies: beta-blockers

In the Low Risk Group, 76.7 % of patients have been prescribed a beta-adrenergic antagonist or beta-blocker (BB) during their first admission, a number which is in accordance with guidelines. There is relatively little variation in the use of BB among hospitals or among CCP's; in almost all hospitals more than half of the patients receive a BB. Concern may be expressed over the fact that only 50-55% of the patients who are re-admitted take a BB, indicating that BB have been stopped in between.

5.3.2. Reperfusion strategies

Thrombolysis

Nearly 30% of patients (10393/34961) have been treated with TL. In A and B1 hospitals this percentage is 48.2 and 44.7 while in CCP B2B3 it is much lower, 27.3 %, which is explained by the fact that these tertiary care hospitals have catheterisation facilities allowing to proceed to P-PCI in treating STEMI.

We cannot evaluate the appropriateness of the use of thrombolytics in this survey because we don't have access to clinical data which are needed to differentiate between STEMI and NSTEMI. The use of TL in this survey, at least in A and B1 hospitals seems high. In the Low Risk Group, almost 50% of patients is treated with TL. This figure is rather high compared to most surveys[57] where TL is found to be applicable in less than 50% of patients (contra-indications, late presentation, non-conclusive ECG, …) specifically presenting with STEMI.

Urgent PCI

In the 1996 guidelines[10], emergency reperfusion treatment of STEMI was focused primarily on TL, but P-PCI was considered a therapeutic option on condition the procedure could be performed early (within 1 hour) by a skilled team. In later guidelines[18], P-PCI indications were more firmly formulated and were extended up to 12 hours after the onset of symptoms, provided the procedure was done by an experienced team and could be accomplished within 90 minutes after the first medical contact. The most recently issued guidelines on PCI[22] conclude that P-PCI and TL are equally effective in reducing infarct size and mortality when delivered within 3 hours after onset of symptoms. Data from the GRACE registry[21], a real-life survey, indicated that patients with an ACS admitted to a hospital without cardiac intervention facilities can be offered standard medical treatment and do not have to be transferred to a tertiary care centre.

Here again we are not able to differentiate between STEMI and NSTEMI. In STEMI the time to reperfusion is of utmost importance, hence the expression "time is muscle". In NSTEMI on the other hand, invasive management is reserved for high-risk patients and CAG is planned without undue urgency.[58]

In the total group of patients, 7.7% (2692/34961) underwent an urgent PCI while this was 10.5% (1461/13868) in the Low Risk Group. However, this figure was 25.2 % in patients with a single stay in a B2B3 hospital. It is of interest to note that 62% of patients that followed one of the scenarios B2B3-A or B2B3-B1 underwent an urgent PCI suggesting that these patients in fact were initially admitted to an A or B1 hospital with immediate transfer to a B2 hospital. Because they did not stay at least during one night in the first hospital, they were not recorded as a hospital stay.

5.3.3. Revascularization

Although analyses from several trials have identified a patent infarct related vessel as a marker for good long-term outcome, it has not been shown that late PCI with the sole aim of restoring patency improves prognosis. Several randomized trials have indicated that in the absence of spontaneous or provokable ischemia the routine use of elective PCI following fibrinolytic therapy compared with a conservative approach does not improve left ventricular function or survival[10]. If however, an AMI patient suffers recurrent ischemic chest discomfort he is considered a candidate for revascularization and he should undergo CAG and revascularization as dictated by coronary anatomy[59]. Once the results of the CAG are known, the optimal revascularization policy following MI refers to the revascularization policy in stable angina[60, 27]. There is no doubt that patients showing a left main stem lesion or a three vessel disease with left ventricular dysfunction should be sent for CABG. But revascularization of patients with single or double vessel disease not involving the proximal LAD and with only a small area of ischemia is poorly supported by current guidelines.

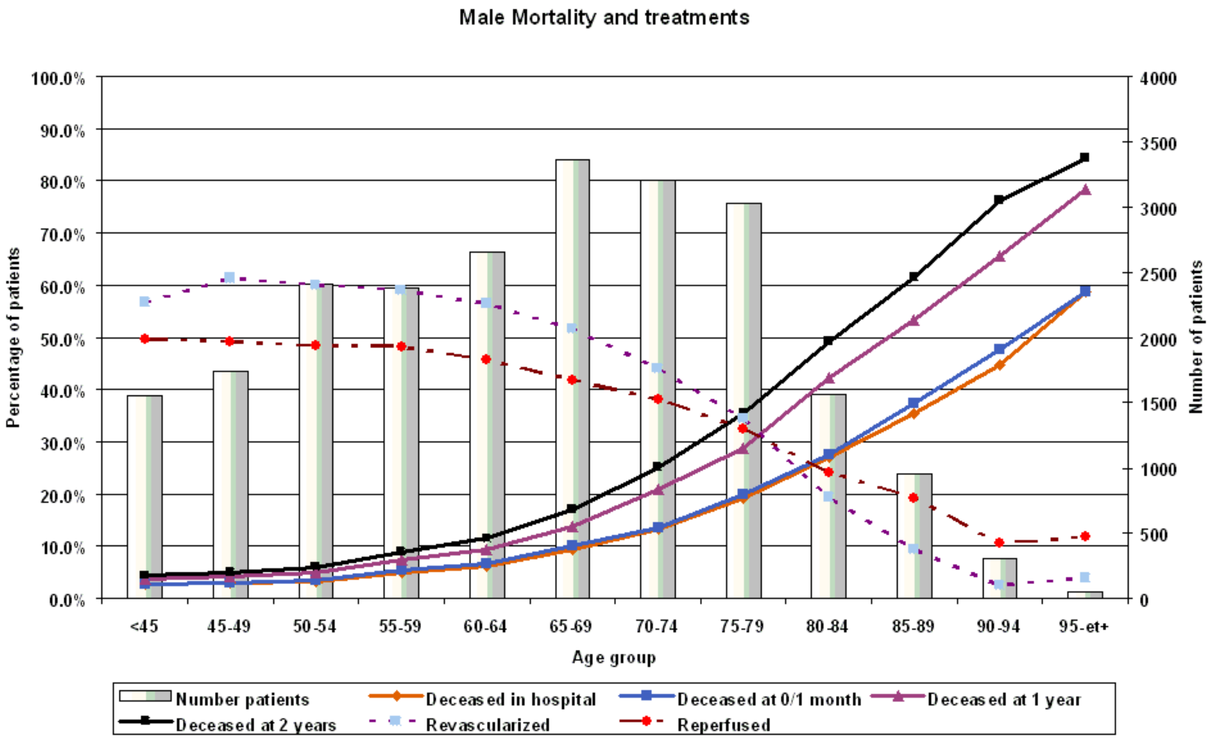
Of the 10393 patients that were treated with thrombolytics, 5410 of them, i.e. 52%, underwent later on a CAG, and more than 90% were revascularized. Of all patients treated conservatively in the acute phase, 8349 out of 22196 underwent a CAG later on. Most of them were revascularized. When considering all patients that underwent a CAG, we see that 89% eventually are revascularized, 16% by means of CABG and 84% by PCI. These high values underscore the validity of the European Society of Cardiology surveys.

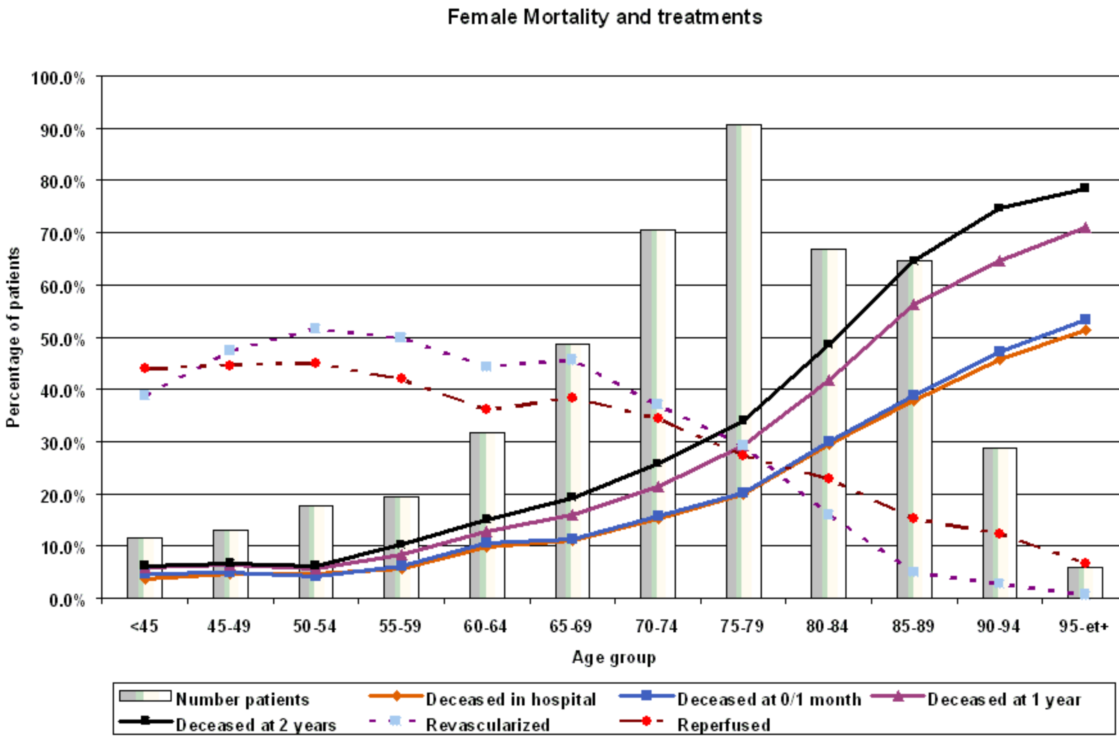
5.3.4. Treatment-Risk Paradox

The expression "treatment-risk paradox" refers to the inverse relationship between the propensity to deliver treatment and the expected patient outcome: the paradox suggests that younger patients are overtreated and older undertreated. It is often encountered in discussions on statin treatment but it has also been used by Wennberg et al when comparing the use of invasive vs medical management of patients with AMI.[61] They confirmed that the availability of cardiac technology and lower patient risk are important determinants for invasive treatment.

Although age is the most important risk factor in patients presenting with AMI, other clinical factors play an important role as well: previous history of IHD, congestive heart failure, diabetes, hypertension, …. In a paper on treatment of ACS[62], Fox elaborates on the fact that an important shortfall in reperfusion therapy exists predominantly among patients with more complicated disease and with advanced age. Specific factors that predict the failure to undergo reperfusion (despite presenting with ST-segment elevation within 12 hours of symptom onset and without contraindications) are previous CABG surgery, diabetes, a presentation with heart failure and age older than 75 years.[63]

Ischemic heart disease disproportionately affects the elderly. Of the 34961 cases of AMI in our series, 62.3 % of them were older than 64 years and 88.0 % of deaths during the month of admission or the month thereafter (month 0-1) occurred in this age group. It is well known that in patients with AMI, age is the strongest predictor of survival. We noted a more than tenfold increase in this short-term mortality between the youngest cohort (< 50 years: 3.2%) and the oldest one (> 80 years: 35.7%). Mortality rates and use of reperfusion and revascularization strategies are depicted in the graphs below. It is clear that elderly patients with the highest mortality rates are much less likely being treated invasively.





We compared therapeutic strategies in our population between patients younger than 65 years and those between 64 and 80 years old. The number of patients from the younger group is treated more invasively although they are at lower risk of death than the older group.

Age	(n) at risk	(n) revasc	(n) thrombolysis	1 month mortality
< 65	13083	7390 (56%)	4789 (37%)	650 (5.0%)
65-79	14838	6062 (41%)	4442 (30%)	2264 (15.2%)

Randomized clinical trials that have included older patients have reported decreased mortality following reperfusion therapy. The original fibrinolytic trials had limited power to demonstrate benefit or hazard among patients more than 75 years of age,[16] but a re-analysis of the Fibrinolytic Trialist's Collaboration in 3300 patients over 75 years, presenting within 12 hours of symptom onset, has demonstrated a significant reduction in mortality from 29.4% to 26%[64]. It is understandable that physicians are somewhat reluctant considering TL in the elderly but they have to be aware that in this way, they deny these patients a relative risk reduction in mortality of more than 10%. In our survey, patients older than 65 yr were much more likely not to receive TL compared to younger ones but it should be stressed that this might be due to the fact that the elderly population contains relatively more NSTEMI patients in whom TL is no therapeutic option.

Because we did not have access to clinical data we could not test whether the treatment-risk paradox applied in our population when risk calculation was based on clinical admission data, other than age. Instead we used a proxy for assessing clinical status on admission by retrieving patients with a cardiovascular history or diabetes. The results in the next table showing data on patients < 75 yr indeed indicate that patients at lower risk have higher revascularisation and thrombolysis rates:

	(n) at risk	(n) revasc	(n) thrombolysis	1 month mortality
High risk	10401	4827 (46%)	3165 (30%)	1397 (13%)
Low risk	12224	6917 (57%)	4718 (39%)	450 (4%)

The difference in the use of invasive therapy between younger and older age groups in our survey is impressive. When considering that in the male age-groups 80-84 and 85-89, respectively 20 % and 10 % are revascularised, we do not think that the treatment-risk paradox applies to this part of the population. Revascularization rates of up to 60 % in patients younger than 60 yrs seem high. The lower intervention level in elderly people may partly be due to the fact that they might have died before an intervention could have been performed. But as far as the patient group aged 65 to 80 yrs is concerned, we expected a higher rather than a lower intervention rate than in younger subjects.

5.4. OUTCOMES

5.4.1. Length of stay

In both GRACE and the EHS the median duration of hospitalization was 8 days for all patients. In this study we can make distinction between stays and episodes. For low risk patients, the median stay was 8 days (1st stay), 2 days (2nd stay), 3 days (3d stay) and 4 days (4th day). The median duration of all stays in the first episode was 10 days in the low risk group and 13 days in the high risk group. For single stay episodes in the low risk groups, patients stayed longer in B1 care facilities (median 10 days) than in B2-B3 facilities (median 8 days) and A facilities (median 9 days). Episodes took 2 days longer if they started in an A or B1 facility than in a B2-B3 hospital. Most of the explained variability in LOS was due to patient characteristics, little variability was explained by hospital characteristics. The interhospital variability was somewhat higher in the B1 facilities.

In a recent study, Kaul et al[41] studied the evolution of LOS following STEMI in different countries during the nineties. The LOS after AMI varied greatly between countries. Although it decreased significantly between 1990 and 1998 in all countries, LOS in European countries was significantly longer compared with North America and Australia and New Zealand. Whereas more than half of the patients were eligible for early discharge (i.e. < 5 days) according to current guidelines, only a very limited number were actually discharged early. The potential for more efficient discharge of low risk patients was found in all countries, but it was especially evident in the European countries included in the study (Belgium, France, Germany, Spain and Poland). Our study suggests that there is probably some improvement in shortening the LOS of very low risk AMI patients in Belgium.

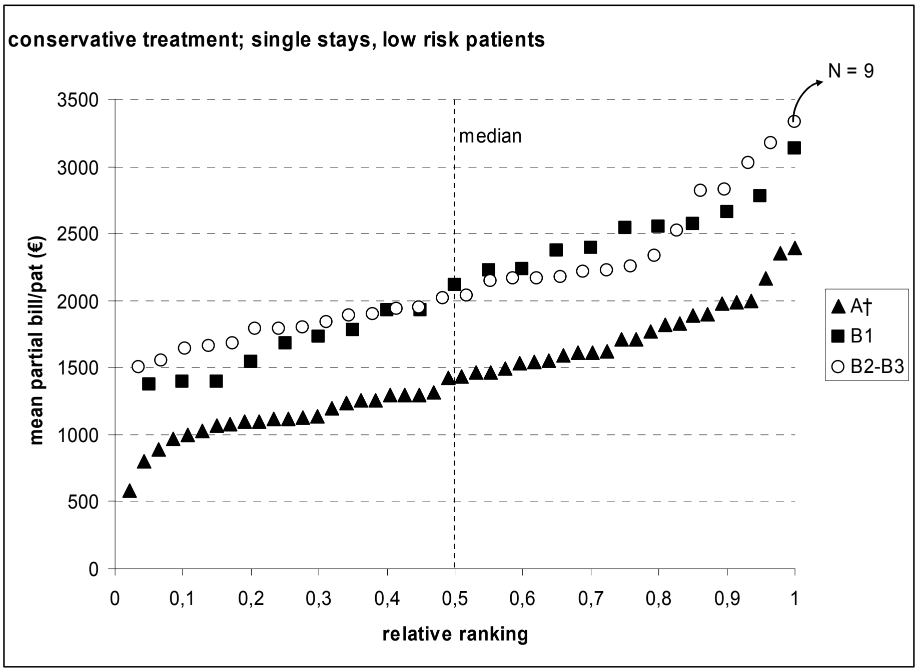
5.4.2. Costs of treatment

Total costs of treatment are an aggregate of cost of LOS and costs for diagnostic and therapeutic interventions. As LOS only explained the variability in costs between hospitals to a minor extent, we focus here on differences between bills. Comparative analyses can be made for single stay episodes from patients at low risk without interventions (PCI or CABG), e.g. thrombolysis and conservative treatment.

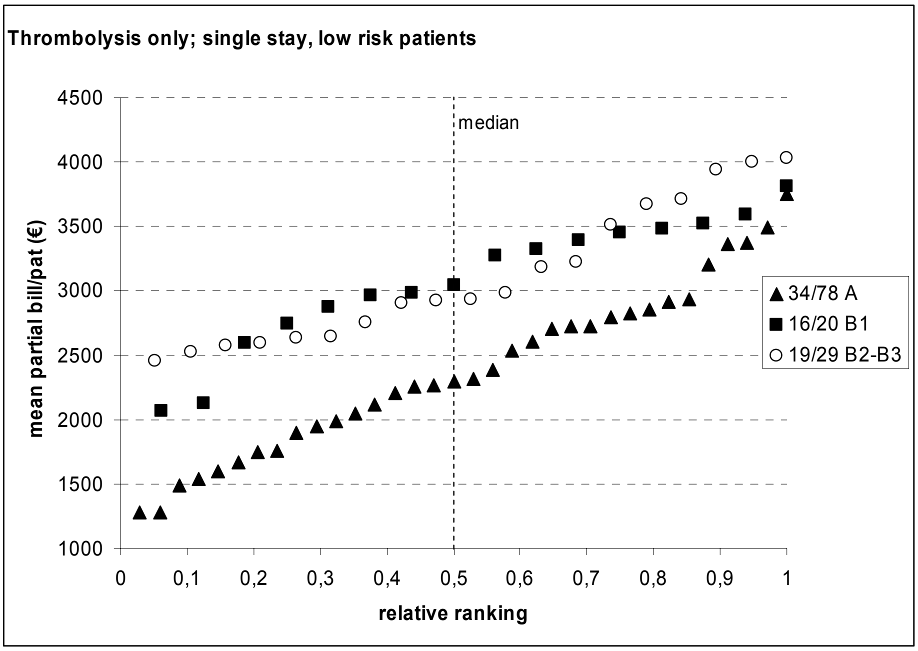
The median partial bill for single stay episodes involving conservative treatment in A hospitals is 1270 €, in B1 hospitals 1890 € and in B2-B3 hospitals 1760 €. The median partial bill for single stay episodes involving thrombolysis in A hospitals is 2250 €, in B1 hospitals 3015 € and in B2-B3 hospitals 2845€.

The graphs show the partial bills (without costs of LOS) by CCP. One B2-B3 hospital, the most expensive, treated only 9 patients conservatively. Thrombolysis was rarer, as the legends in the figure show.

If the patients were a truly homogeneous group (they are younger, without previous cardiovascular history, without diabetes, and at low mortality) and treatment was standard, a small increase caused by random error would ensue. The figure shows that the span between cheaper and more expensive hospitals is large, indicating large variability in resource use. For the same conservative treatment in a low risk group of patients at good prognosis, the costs per patient (costs of LOS excluded) varied between 1000 € (the 10th percentile of the cheaper A hospitals) and 2660 €/2830€ (the 90th percentile of the B1/B2-B3 hospitals). For thrombolytic treatment in a low risk group of patients at good prognosis and younger age, the costs per patient (costs of LOS excluded) varied between 1500 € (the 10th percentile of the cheaper A hospitals) and 3500 €/3900€ (the 90th percentile of the B1/B2-B3 hospitals).



† 10 patients or more



Legends show the nr of hospitals with 10 patients or more. The Y-axis has been moved down for direct comparison.

5.4.3. Mortality

Overall short term mortality was 15.5 %, occurring mainly during the first hospital stay (13.6%). The percentage of patients dying during the first day of the index admission was 5.2%. Absolute levels of mortality after acute coronary syndromes are difficult to interpret and to compare with international benchmarks: case fatality is sharply dependent on the definition ("unstable angina pectoris" having a better prognosis), the demography (case fatality is sharply correlated with age) and whether one considers patients admitted to hospital or one includes all. The MONICA study for example considers all case where case fatality is about 50% in the two Belgian centres (Figure 1)[44] . All patients arriving into the hospital are survivors selected by mortality before reaching the hospital. International comparisons show that most variability in mortality is caused at patient level, not hospital or country level. [65]

G17

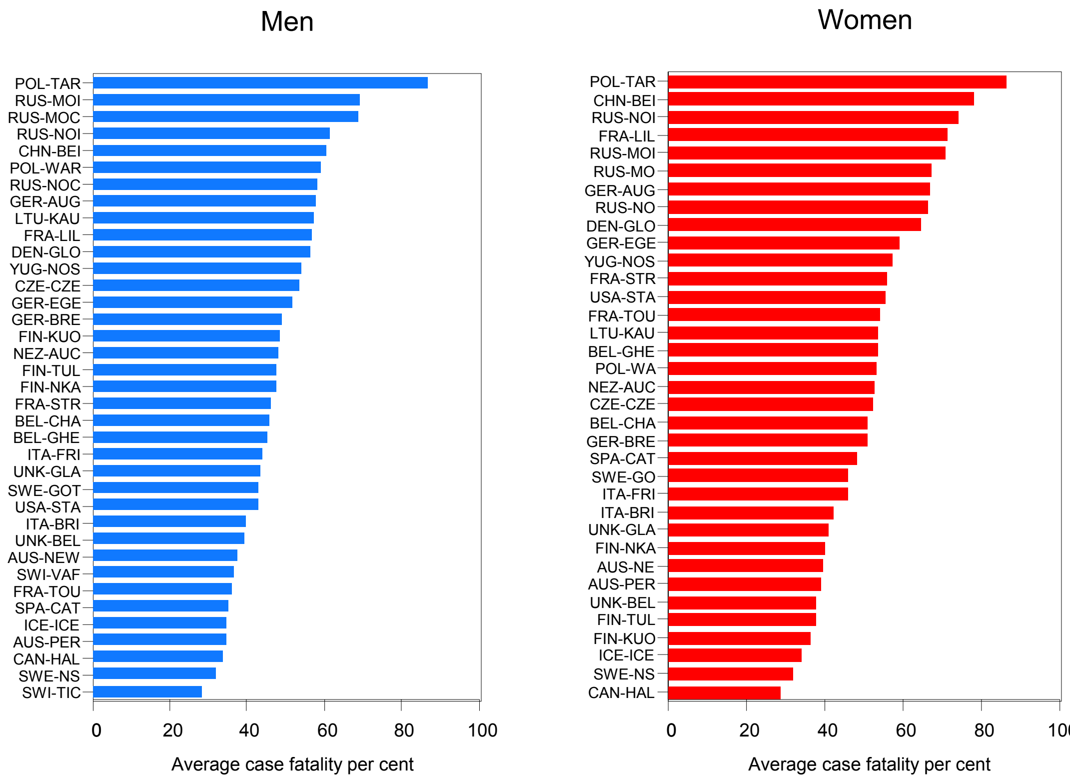


Figure 1 Case fatality of acute coronary events observed in MONICA studies: Bel-Ghe and Bel-CHA refer to Ghent and Charleroi, the cooperating Belgian centers.

Short term mortality was predicted by age (+ 122% per decade of age), gender (OR of female mortality was 12% higher), cardiovascular history (OR + 22%) and diabetes (OR +23%). These results are consistent with many studies and confirm the validity of our results. In a Cox regression model of long term mortality, the effect of gender disappeared. After an MI Belgian women lose the advantage of lower mortality that characterises female gender. Previous history of cardiovascular disease and diabetes increase the long term mortality risk (+42%). When considering short and long term mortality of patients in relation to the CCP where they were initially admitted, we found no statistically or clinically significant difference after adjustment for known baseline characteristics. Taking B2-B3 as reference level, the long term mortality was 1% higher in A services and 3% in B1 services, but this can be easily explained by chance. So was the short term mortality relatively 3% higher in B1 services and 5% in A services, but as numbers are smaller, the error margins are wider and this is therefore even less meaningfull. To note: this does not imply that the specific treatments are equivalent, but that appropriate referral makes a first admission in a A hospital is not disadvantageous to the patient. This is in agreement with the findings of the GRACE registry [21] in which patients were included covering the whole spectrum of ACS. Their results apply to STEMI considered separately as well. The risk of death in patients with STEMI first admitted to a hospital with catheterisation facilities did not differ significantly from that in patients admitted to a hospital without catheterisation facilities, despite the fact that P-PCI was more common in the hospitals with such facilities (26% vs 0.9%). We lack information on transfer of patients that are initially admitted to an A or B1 hospital but are immediately transferred to a B2-B3 without a registered stay. This might cause an undetectable bias, if referred patients are worse off than in B2-B3 hospitalised unreferred patients. However, the mix of patients in A hospital tends to be older and female, hence with less good prognosis, suggesting that it is not very plausible that referred patients have an a priori worse prognosis. The opposite would be more likely.

Comparing different treatments used in different CCP's can not be justified in an administrative database. Appropriate comparisons between PCI and thrombolysis can only be made by an RCT. While the probability of arriving in a specific CCP hospital can be considered as occurring more or less independent of prognostic indicators, treatment depends on the decision of the attending physician and is "confounded by indication" and by the availability of interventional facilities. Patients initially admitted to a B2-B3 hospital were slightly more reperfused (38.0%) than those admitted to an A (36.2) or B1 (34.0) hospital but the mode of reperfusion applied was different: virtually all patients in A and B1 hospitals were reperfused by means of TL, in B2-B3 hospitals patients were roughly equaly treated by urgent PCI or TL (19.7 vs 20.6%). Revascularised patients have a better prognosis, as they survived till revascularisation. The observed variability in mortality outcomes between B2-B3 hospitals is within reasonable ranges, and can be explained by chance and/or selective referral of patients at poor prognosis. We omitted confidence limits to avoid overinterpretation (in multiple comparisons, some will have a 'significantly' increased or decreased mortality due to chance only).

5.5. NEED FOR REGISTRIES

More detailed registration of patients presenting with ACS is needed, especially to be able to differentiate between STE-ACS and NSTE-ACS, because different therapeutic strategies apply to both types of ACS. Needs for registries will even increase when more expensive technology is made available, such as drug eluting stents. Continuing surveys and registries are essential to reassess the quality of care and the appropriateness of use at regular intervals and these should be considered together with clinical data registration systems from national registries such as the one presented here. At this moment, the financial support for the former surveys and registries comes from the international societies of cardiology, national heart foundations and pharmaceutical and medical device industries. The latter carries the risk that these studies may be limited to areas of significant industrial financial interest. Fortunately, existing registries such as the one from the Belgian Working Group for Invasive Cardiology can be used for peer-review. These registries should be further developed and implemented in a close collaboration between professionals, health insurance and regulatory bodies. In this respect, we can only welcome the efforts of the ESC to harmonize data collection of clinical practice throughout Europe by means of the CARDS (The Cardiology Audit and Registration Data Standards).[66] We recommend that participation to a registry for all invasive procedures should be made mandatory for accreditation as a B2-B3 centre.

5.6. FUTURE OPTIONS FOR THE ORGANISATION OF CARDIAC CARE SERVICES

Belgium has a high number of hospitals performing PCI and CABG (B2 and B3 centres) compared to many other OECD countries (3.0 per 1 000 000 inhabitants). In addition, Belgium disposes of 20 B1 hospitals, licensed to perform diagnostic coronarographies only. Treatment by PCI is officially not permitted in these centres. However, in B1 centres the technical facilities for PCI are present and the cardiologists working in these centres were either trained in PCI or are even working simultaneously in a B2 centre. This explains the demand of individual B1 centres to allow PCI in these centres, at least for ACS. This means that we have a total of 50 hospitals with catheterisation facilities in Belgium (or 5.0 per 1 000 000 inhabitants). As increased supply induces increased demand, this will certainly increase health care costs. Will it increase health benefits?

Recent evidence from multinational registries [21] shows that patients with ACS admitted first to hospitals with catheterisation facilities did not have a survival benefit. After adjustment for differences in baseline risk, medical history, and geographical region, survival benefits at six months in patients without such access was not worse. Our findings confirm that, in Belgium, patients first admitted in an A, B1 or B2-B3 setting have an identical prognosis in the short and the long run.

Patients with suspected AMI can be hospitalized in the nearest hospital, irrespective of the availability of interventional facilities. An early transfer to tertiary care hospitals is safe, and only indicated in appropriately selected patients.[19, 22]

As we miss important predictors of both disease severity and individual operator experience, a volume-outcome relationship for the invasive treatment of AMI could not be studied. A volume-outcome relationship in interventional cardiology has been described in other countries [67, 68], although concerns have been raised.[69] Even in the contemporary era of coronary stents, performance of PCI in high-volume institutions or by high-volume operators is associated with improved outcomes in the majority of studies.[70-72] So, there is a danger that a too high number of interventional cardiac care facilities will dilute experience.

The individual operator's experience is another point of concern. Specifically for primary PCI as a timeliness treatment modality for AMI, a whole team constituted of an experienced interventional cardiologist and a experienced catheterization laboratory team available 24 hours a day, seven days a week. The same goes for cardiac surgery as treatment modality or as bail-out therapy for failed PCI of which the frequency is maybe low but not zero.[73, 74] This poses several organisational challenges for a B2/B3 hospital and it is unclear whether all the B2 centres are able to meet these standards including the presence of a high-volume operator continuously, especially in low volume B2 centres. Likewise, some cardiologists from non-B2 centres are performing mostly planned invasive cardiology procedures in B2 centres without their individual experience or appropriateness of their procedures being assessed. A more widespread introduction of a detailed registry for all invasive diagnostic and therapeutic procedures as discussed in the previous section can support quality assurance and outcomes monitoring.

The unbalanced regional distribution of B2-B3 centres, with many centres in the capital and few in the periphery of the country, suggest an equity problem. We recommend to limit the B2-B3 centres where they are in abundance, and to strengthen the criteria in the programming of the B2-B3 centres, based on quality indicators such as appropriate use of diagnostic technology. In the deep South, the far West and the North-East of Belgium the tertiary care offer is limited and might be expanded (an interesting alternative would be more transnational cooperation, e.g. with Luxembourg). Alternatively, emergency transportation facilities between hospitals can be optimized.

Whether hospitals with facilities for interventional cardiology (B2) should perform PCIs without an on site coronary artery bypass graft (CABG) surgery program (B3) is an ongoing matter of debate.[75 74 73]. Promoting PCI in hospitals without cardiac surgery may inadvertently lead to an overall increase in especially the mortality related to elective PCI.[76] In underserved areas with a low population density that are far removed from other centres, PCI without onsite CABG facilities can be defended, but these conditions do rarely apply to Belgium. The American College of Cardiology[77] recommended that given the concerns regarding operator volume and surgical standby, PCI would best be performed at a high-volume center (>400 cases/year) associated with an on-site cardiovascular surgical program. In the recent guidelines of the European Society of Cardiology[22] on site cardiac surgical back up was not discussed due to potentially different points of view[78]. Given the already widespread availability of B2/B3 centres in Belgium and the diminishing number of CABG being performed, a further increase of the number of cadiac surgery centres cannot be justified.

The number of Belgian B1 centres and its geographical distribution is extraordinary (see page 39). An intermediate care level with expanded diagnostic facilities adds no value to the treatment of a MI. It diminishes the quality of care: coronary angiographies need to be doubled up if an intervention is needed. The patient needs two invasive procedures in two different hospitals for one medical problem, with an associated increase in risk of complications and discomfort. The economic consequences are substantial. The cost for the multiplication of procedures has to be reimbursed, and the facilities for cardiac catheterization and the personnel have to be paid for. B1 centres were even more expensive in the care of patients with a myocardial infarction then B2-B3 hospitals, and used more inappropriate non-invasive diagnostic testing.

In cardiology, technology moves fast. We recommend repetition of this study as soon as reliable data from 2006 are available (2009). This study should evaluate the recommendations, compare the resource use in 2006 with the results of this study and evaluate the outcomes.

6. APPENDIX

APPENDIX A: HISTORIC OVERVIEW OF GUIDELINES ON TREATMENT OF ACS

This table summarizes chronologically European (ESC) and American (ACC/AHA) guidelines for the treatment of ACS.

STE-ACS			
TREATM	YEAR	ESC	ACC/AHA
INITIAL	1996 "ACUTE MI"	aspirin, TL (<12h); P-PCI is a therapeutic option only when rapid access (<1h) to a catheterization laboratory is possible; iv BB in case of tachycardia, pain, hypertension; ACE < 24 h level 3;	aspirin; TL (< 12h); P-PCI may be performed if accomplished timely and skilled; iv BB if no CI; early ACE unless CI;
	1999 = 1996 UPDATE "AMI"	NA	aspirin, continued indefinetely; TL < 12h; P-PCI if within 12 h of onset of symptoms or beyond 12 h if ischemic symptoms persist if performed timely (i.e. within 90 min of admission) by skilled persons;
	2003 (ESC) - 2004 (ACC)	aspirin; TL (<12h); heparin; P-PCI if performed within 90 min after the first medical contact; early i.v. use of BB to be considered;	aspirin; heparin; BB; TL (<12h); heparin; P-PCI if performed within 90 min after the first medical contact and within 12 hours of symptom onset; ACE within 24 h in large infarctions;
SUBSEQUENT	1996	no routine use of coronary angiography or elective PTCA following thrombolysis; further investigation c.q. ptca indicated in treating angina or recurrent ischemia or in case of impaired LV function;	aspirin; BB; ACE at least 6 weeks; coronary angio for recurrent chest pain, associated with objective evidence in patients candidates for revascularization;
	1999 = 1996 UPDATE	NA	no place for routine coronary angiography and PTCA after succesful thrombolytic therapy
	2003 (ESC) - 2004 (ACC)	angiography in high risk pts or when EF 35% or extensive residual ischemia;	in case of severe symptoms (class I), high-risk findings on non-invasive testing (class I), reasonable in diabetics or when EF < 40% (class lia).
ON DISCHARGE	1996	aspirin, beta blocker in pts at moderate risk without contra-indications; target > 35%; ACE in patients who experienced heart failure in the acute episode or with depressed left ventricular function (EF<40%) target > 20%; lipid lowering agents for patients	aspirin; ACE if ejection fraction < 40% or CHF; BB therapy for all but low-risk patients without a clear contraindication; treatment should begin within a few days of the event (if not initiated acutely) and continue indefinitely.

STE-ACS			
TREATM	YEAR	ESC	ACC/AHA
		who correspond to those recruited into 4S;	
	2003 (ESC) - 2004 (ACC)	aspirin, BB in all pts without contraindications, ACE at least in case of lv dysfunction (EF < 40%); statins when total cholesterol > 190 mg% or LDL > 115 mg%;	aspirin; BB; ACE; statin if LDL-C > 100 mg%;

NSTE-ACS			
TREATM	YEAR	ESC	ACC/AHA
LOW RISK	1996	aspirin, no thrombolysis; no difference in outcome between early invasive vs early conservative therapy;	aspirin; BB (class IIb indication); no TL;
	2000	BB; aspirin; LMWH; no TL; angio if stress-test shows significant ischemia;	aspirin, BB, LMWH; either early conservative or early invasive strategy;
	2002	BB; aspirin; clopidogrel; LMWH; no TL; angio depending on stress test;	BB; aspirin; clopidogrel; heparin; either early conservative or early invasive strategy;
HIGH RISK (recurrent ichemia, elevated troponin, hemodynamic instability, major arrhythmias)	1996	aspirin, no thrombolysis; ACE in high risk (heart failure, previous MI); angiography and revascularisation should be considered if spontaneous or readily provoked ischemia can be detected or in case of impaired LV function;	aspirin; angiography and/or intervention if recurrent ischemia, shock, pulmonary congestion;
	2000	BB; aspirin; LMWH; no TL; IIbIIIa before angio and continued 12-24 hours after pci; angiography followed by revascularization;	aspirin, BB, LMWH, IIbIIIa; early invasive strategy;
	2002	BB; aspirin; heparin clopidogrel; no TL; IIBIIIA ; angio in high risk;	BB; aspirin; clopidogrel; heparin; IIbIIIa; early invasive therapy;
ON DISCHARGE	1996	aspirin, beta blocker in pts at moderate risk without contra-indications; target > 35%; ACE in patients who experienced heart failure in the acute episode or with depressed left ventricular function (EF<40%) target > 20%; lipid lowering agents for patients who correspond to those recruited into 4S;	aspirin; lipid lowering drugs for patients with LDL > 125 on diet; BB therapy for all but low-risk patients without a clear contraindication; treatment should begin within a few days of the event (if not initiated acutely) and continue indefinitely.
	2000	BB; aspirin; lipid lowering therapy;	asprin, BB, lipid lowering drugs if LDL > 125; ACE if CHF, EF<0,40, HT or diabetes;

NSTE-ACS			
TREATM	YEAR	ESC	ACC/AHA
	2002	aspirin; clopidogrel, 9-12 months; BB; statins;	aspirin; clopidogrel; BB; statins; ACE (for EF < 40%);

APPENDIX B: HOSPITALS NAMES

B1 : CARDIAC CARE PROGRAM B1 HOSPITALS (20)

Hospital	Commune
ALGEMEEN ZIEKENHUIS GROENINGE	KORTRIJK
A.Z. MONICA V.Z.W.	DEURNE
ALGEMEEN ZIEKENHUIS ST. AUGUSTINUS	WILRIJK
CLINIQUE SAINT PIERRE	OTTIGNIES
CLINIQUE LOUIS CATY	BAUDOUR
CLINIQUE NOTRE-DAME ET REINE FABIOLA	CHARLEROI
CENTRE HOSPITALIER UNIV. A. VESALE	MONTIGNY-LE-TILLEUL
CENTRE HOSPITALIER REGIONAL DE HUY	HUY
CLINIQUES SAINT-JOSEPH	LIEGE-1
CLINIQUES DU SUD-LUXEMBOURG	ARLON
CENTRE HOSPITALIER DE L'ARDENNE	LIBRAMONT
CENTRE HOSP. REGIONAL DU VAL DE SAMBRE	AUVELAIS
ALGEMEEN ZIEKNHUIS DAMIAAN	OOSTENDE
CHIREC (Ex-Cavell B1 agreement)	BRUXELLES
CH ST-JOSEPH - WARQUIGNIES	MONS
CHR MOUSCRON	MOUSCRON
CH BOIS ABBAYE	SERAING
CH PELTZER - LA TOURELLE	VERVIERS
PROVIDENCE DES MALADES ET MUTUALITÉ CHRÉTIENNE	BOUSSU
CLINIQUE MATERNITÉ ST-ELISABETH	NAMUR

Hospitals that were B1 between 1999 and 2004 were included in the list.

B2 : CARDIAC CARE PROGRAM B2 HOSPITALS (29)

Hospital	**Commune**
ALGEMEEN ZIEKENHUIS ST.-JAN	BRUGGE
HEILIG HART ZIEKENHUIS	ROESELARE
ALGEMEEN ZIEKENHUIS MIDDELHEIM	ANTWERPEN
IMELDA ZIEKENHUIS	BONHEIDEN
KLINIEK ST.-JAN	BRUSSEL

Hospital	**Commune**
CLINIQUES DE L'EUROPE (ex: ST ELISABETHZIEKENHUIS)	BRUSSEL
CENTRE HOSPITALIER UNIV. ST.PIERRE	BRUXELLES
HÔPITAUX IRIS-SUD (ex : CH J.BRACOPS)	BRUXELLES
CENTRE HOSPITALIER UNIV. BRUGMANN	BRUXELLES
ONZE LIEVE VROUW ZIEKENHUIS	AALST
AALSTERS STEDELIJK ZIEKENHUIS	AALST
KLINIEK MARIA MIDDELARES	GENT
UNIVERSITAIR ZIEKENHUIS	GENT
CENTRE HOSPITALIER UNIV. DE CHARLEROI	CHARLEROI
HOSPITAL ST.-JOSEPH, STE.-THERESE ET IMTR.	GILLY
CENTRE HOSPITALIER JOLIMONT - LOBBES	HAINE-SAINT-PAUL
CENTRE HOSPITALIER UNIVERSITAIRE TIVOLI	LA-LOUVIERE
CENTRE HOSPITALIER UNIV. DE LIEGE	LIEGE (SART-TILMAN)
ZIEKENHUIS OOST - LIMBURG	GENK
VIRGA JESSE ZIEKENHUIS	HASSELT
CLINIQUES UNIVERSITAIRES (U.C.L.)	MONT-GODINNE
CENTRE HOSPITALIER REGIONAL	NAMUR
CLINIQUE ST. LUC	BOUGE
CLINIQUES UNIVERSITAIRES ST. LUC	BRUXELLES
AKADEMISCH ZIEKENHUIS (V.U.B.)	BRUSSEL
CLIN. UNIV. DE BRUXELLES - HOSPITAL ERASME	BRUXELLES
UNIVERSITAIR ZIEKENHUIS ANTWERPEN	EDEGEM
CENTRE HOSPITALIER REGIONAL DE LA CITADELLE	LIEGE
UNIVERSITAIRE ZIEKENHUIZEN K.U.L.	LEUVEN

APPENDIX C: CODES USED IN PATIENTS SELECTION

C1 : DIAGNOSTIC BILLING CODES

English Translation	Code	Label_RIZIV
ANGIOCARDIOGRAPHY	453106	Bloedvatenstelsel : Angiocardiopneumografie, maximum voor het ganse onderzoek, twee of meer invalshoeken (minimum zes clichés per invalshoek
	464100	Bloedvatenstelsel Angiocardiopneumografie, maximum voor het ganse onderzoek, twee of meer invalshoeken (minimum zes clichés per invalshoek)
CORONARY ANGIOGRAPHY	453143	Bloedvatenstelsel : Coronarografie, één of twee kransslagaders, maximum voor het geheel van twee of meer invalshoeken (minimum zes clichés per invalshoek)
	453121	Bloedvatenstelsel : Coronarografie, één of twee kransslagaders, één invalshoek, minimum zes clichés
	464122	Bloedvatenstelsel Coronarografie, één of twee kransslagaders, één invalshoek, minimum 6 clichés
	464144	Bloedvatenstelsel Coronarografie, één of twee kransslagaders, maximum voor het geheel van twee of meer invalshoeken (minimum 6 clichés per invalshoek)
PULMONARY DIFFUSION CAPACITY	471365	Meten van diffusiecapaciteit
CAROTID DUPLEX ULTRASOUND	460320	Cardiovasculaire echografieen : Bilateraal duplexonderzoek van de carotisslagaders dat een echografisch beeld en Doppler met frequentie-analyse van de signalen omvat, met protocol en uittreksels
	460342	Cardiovasculaire echografieen : Bilateraal duplexonderzoek van de arteria carotis en van de arteria vertebrales dat een echografisch beeld en Doppler met frequentie-analyse van de signalen omvat, met protocol en uittreksels
EXERCISE TESTING	475823	Inspannings- of hypoxieproef, met continue monitoring van minstens één afleiding voor elke belastingsverandering, op het einde van de proef en gedurende minstens drie minuten na het beëindigen van de proef, meerdere elektrocardiografische registraties op verschillende afleidingen en arteriële bloeddrukmetingen, met uittreksels en gestandaardiseerd protocol
PHARMACODYNAMIC ECG TESTING	475543	Farmacodynamische proef, gevolgd door elektrocardiografische controles, met protocol
REST ECG	475086	Elektrocardiografische onderzoekingen, met protocol, ten minste 12 verschillende derivaties

English Translation	Code	Label_RIZIV
ECG-MONITORING, COMPBINED WITH INVASIVE MONITORING OF BLOOD PRESSURE A/O CENTRAL VENOUS PRESSURE	214045	Continu toezicht op de hartfunctie (met of zonder toezicht op andere vitale waarden) met een waaktoestel dat, benevens het elektrocardiogram, op zijn minst bestendig een van de volgende parameters volgt : de arteriële druk door middel van een intraarteriële catheter, de intracavitaire of pulmonale druk door middel van een intracardiale catheter, de intracraniële druk door middel van een intracraniële catheter (buiten de narcoses, de heelkundige en verloskundige bewerkingen en buiten de functionele harttests), inclusief de eventuele registraties : De tweede, derde, vierde en vijfde dag, per dag
	214023	Continu toezicht op de hartfunctie (met of zonder toezicht op andere vitale waarden) met een waaktoestel dat, benevens het elektrocardiogram, op zijn minst bestendig een van de volgende parameters volgt : de arteriële druk door middel van een intraarteriële catheter, de intracavitaire of pulmonale druk door middel van een intracardiale catheter, de intracraniële druk door middel van een intracraniële catheter (buiten de narcoses, de heelkundige en verloskundige bewerkingen en buiten de functionele harttests), inclusief de eventuele registraties : De eerste dag
ECG-MONITORING	212026	Continu toezicht op de hartfunctie (met of zonder toezicht op andere vitale waarden) met een waaktoestel dat op zijn minst bestendig het electrocardiogram volgt, inclusief de eventuele registraties, buiten de narcoses, de heelkundige en verloskundige bewerkingen en buiten de functionele harttests: de eerste dag
ECG-MONITORING	212041	Continu toezicht op de hartfunctie (met of zonder toezicht op andere vitale waarden) met een waaktoestel dat op zijn minst bestendig het elektrocardiogram volgt, inclusief de eventuele registraties, buiten de narcoses, de heelkundige en verloskundige bewerkingen en buiten de functionele harttests : De tweede en derde dag, per dag 212030-212041 mogen niet worden samengevoegd met 475031475042, 475075-475086 en 475451-475462 (1.8.1988)
ECHOCARDIOGRAPHY	460445	Cardiovasculaire echografieen : Transthoracale mono- en bidimensionele echocardiografie (met respectievelijk ten minste 3 en 2 coupes en registratie op papier en/of magneetband), gecombineerd met registratie van minimum 3 snelheden in continue of gepulseerde Doppler
	460423	Cardiovasculaire echografieen : Transthoracale mono- en bidimensionele echografie (met respectievelijk ten minste 3 en 2 coupes en registratie op papier en/of magneetband)
	460460	Cardiovasculaire echografieen : Transthoracale mono- en bidimensionele echografie (met respectievelijk ten minste 3 en 2 coupes en registratie op papier en/of mangneetband), gecombineerd met de kleurenregistratie ervan van minimum 3 snelheden in continue of gepulseerde Doppler
TRANSOESOPHAGEAL ECHOCARDIOGRAPHY (TEE)	460585	Cardiovasculaire echografieën : Transoesophagale mono- of bidimensionele echocardiografie (met respectievelijk tenminste 3 en 2 coupes en registratie op papier en/of magnetische drager), gecombineerd met de kleurenregistratie ervan aan minimum drie snelheden in continue of gepulseerde Doppler
ELECTROPHYSIOLOGICAL STUDY (EPS)	476280	Uitgebreid electrofysiologisch onderzoek voor het opwekken en beëindigen van tachycardieën met behulp van drie of meer catheters,inclusief afname van bloedstalen, radioscopische en electrocardiografische controles, toediening van farmaca en contraststoffen, met protocol en tracés

English Translation	Code	Label_RIZIV
	476302	Beperkt elektrofysiologisch onderzoek tot studie van de sinusknoopfunctie en van de atrioventriculaire geleiding met behulp van een of meerdere catheters met inbegrip van de electrocardiografische opnamen
ERGOSPIROMETRY	471402	Ergospirometrie
STUDY OF VENTILATION MECHANICS	471380	Studie van de ventilatiemechaniek
AMBULATORY 24-HOUR-ECG MONITORING	476221	Monitoring Holter : Continu elektrocardiografisch registreren gedurende ten minste 24 uur,door middel van een draagbaar toestel met magneetband of met ingebouwd geheugen, inclusief de raadpleging bij het plaatsen en het wegnemen van het toestel, met protocol en mogelijkheid tot reproduceren van de volledige tracés
	476243	Herhaling binnen een jaar van verstrekking nr 476210 - 476221
IDEM WITHOUT FULL-DISCLOSURE	476265	Monitoring Holter : continue electrocardiografische analyse gedurende ten minste 24 uur, door middel van draagbaar toestel, inclusief de raadpleging bij het plaatsen en het wegnemen van het toestel met protocol en mogelijkheid tot reproduceren van een deel van de tracés
AORTOGRAM	453246	Bloedvatenstelsel : Radiografie van de aorta thoracalis en/of abdominalis en van de vertrakkingen ervan, minimum drie clichés (mag niet worden gecumuleerd met verstrekking nr. 453294-453305, dezelfde dag verricht)
	464240	Bloedvatenstelsel Radiografie van de aorta thoracalis en/of abdominalis en van de vertakkingen ervan, minimum drie clichés (mag niet worden gecumuleerd met verstrekking nr 464295-464306, dezelfde dag verricht)
CHEST X-RAY	452723	Ademhalingsorganen : Radiografie van de thorax en de inhoud ervan, minimum twee clichés
	452701	Ademhalingsorganen : Radiografie van de thorax en de inhoud ervan, één cliché
CARDIAC RADIONUCLIDE IMAGING	442422	Scintigrafie van een orgaan, van een stelsel of van een deel van het lichaal buiten die genoemd onder de nrs. 442433 - 442444 of 442470 - 442481
	442400	Scientigrafieën en tomografische onderzoeken Tomografisch onderzoek tijdens een scintigrafie, met verwerking op computer die ten minste twee niet-parallelle reconstructievlakken omvat, met protocol en iconografische documenten, niet cumuleerbaar met de verstrekkingen 442411-442422, 442455-442466, 442610-442621 en 442632-442643 voor het onderzoek van een zelfde orgaan of stelsel van organen dat met een zelfde gemerkt produkt wordt verricht
	442606	Functionele scintigrafische test die twee opeenvolgende tomografische onderzoeken omvat, met verwerking op computer, die ten minste twee niet-parallelle reconstructievlakken omvat, met protocol en iconografische documenten, niet cumuleerbaar met de verstrekkingen 442411-442422, 442455-442466, 442610-442621 en 442632-442643 voor het onderzoek van een zelfde functie dat met een zelfde gemerkt produkt wordt verricht

English Translation	Code	Label_RIZIV
	442621	Functionele scintigrafie van een orgaan of stelsel van organen,met test sequentele inzameling van de gegevens, kwantitatieve analyse met telsysteem (computer) die activiteitscurven in de tijd en/of tabellen met cijfergegevens en/of parametrische beelden omvat, met protocol en iconografische documenten
RESPIRATORY MINUTE VOLUME	471262	Volledige spirografie met bepalen van maximum adem minuten volume
INVASIVE HEMODYNAMIC MONITORING (SWAN-GANZ)	212225	Hartcatheterismen met het oog op het plaatsen van één of meerdere catheters langs veneuze weg voor tijdelijke atriale en/of ventriculaire stimulatie en/of voor monitoring van de drukken of van de hartdebieten, inclusief de eventuele radioscopische controles met televisie, denudatie, elektrocardiografische controles
VECTORCARDIOGRAM	475322	Vectocardiogram
RESIDUAL LUNG VOLUME	471321	Bepalen van het residuair volume

C2: PCI AND CABG BILLING CODES

CATEGORIE	Code	Label_RIZIV
CABG	229622	Myocardrevascularisatie uitgevoerd met een slagaderent (mammaria, gastroepiploica of geëxplanteerde slagader) inbegrepen de eventuele geassocieerde veneuze bypass(en)
	229585	Myocardrevascularisatie door anastomose met behulp van de arteria mamalia interna, met aanwending van de twee arteriae mamaliae internae of implantatie van de arteria mamalia interna in de vorm van sequentiële overbruggingen
PTCA	589024	Vasculaire transluminale percutane behandelingen : Percutane endovasculaire dilatatie met of zonder plaatsing van stent(s) onder controle door medische beeldvorming van een vernauwing en/of occlusie van een kransslagader, inclusief de manipulaties en controles tijdens de behandeling en al het gebruikte materieel, met uitsluitingvan de dilatatiecatheter, de farmaca en de contrastmiddelen : voor het geheel van de kransslagaders

C3 : BETA-BLOCKERS

ATC5	Lib_ATC5	Brand in Belgium
C07AA01	Alprenolol	APTINE
		APTINE 50
		APTINE RETARD 20
C07AA02	Oxprenolol	TRASICOR 80
C07AA03	Pindolol	VISKEN
C07AA05	Propranolol	INDERAL
		INDERAL RETARD
		INDERAL RETARD M
		PROPAM
		PROPRANOLOL
		PROPRANOLOL EG
		PROPRANOLOL RETA
		PROPRAPHAR
		PROPRAPHAR RETAR
C07AA06	Timolol	BETIM
		BLOCADREN
C07AA07	Sotalol	BLOCAXAN
		MERCK-SOTALOL 16
		SOTALEX
		SOTALOL BC 160 m
		SOTALOL BEXAL 16
C07AA12	Nadolol	CORGARD
C07AA16	Tertatolol	ARTEX
C07AB01	Practolol	ERALDIN
C07AB02	Metoprolol	LOPRESOR
		LOPRESOR OROS 10
		LOPRESOR OROS 20
		LOPRESOR OROS 30
		METOPHAR 100 mg
		METOPHAR 50 mg
		SELOKEN
		SELOKEN 10 mg
		SELOZOK 100
		SELOZOK 200
		SELOZOK 50
		SLOW LOPRESOR
C07AB03	Atenolol	ATEBLOC
		ATENOLOL BC 100
		ATENOLOL BC 50 m

ATC5	Lib_ATC5	Brand in Belgium
		ATENOLOL EG 100
		ATENOLOL EG 25 m
		ATENOLOL EG 50 m
		ATENOLOL MERCK 1
		ATENOLOL MERCK 5
		ATENOLOL-RATIOPH
		ATENOMED 100
		ATENOMED 50
		ATENOTOP
		ATEPHAR 100
		ATEPHAR 25
		ATEPHAR 50
		ATHENOL
		BLOKIUM-100
		BLOKIUM-50
		DOCATENO 100
		DOCATENO 50
		KELATENOR 100 mg
		KELATENOR 50 mg
		TENORMIN
		TENORMIN MINOR 2
		TENORMIN MITIS 5
		TENORMIN-100
C07AB04	Acebutolol	ABUTOPHAR
		SECTRAL
		SECTRAL GE
C07AB05	Betaxolol	KERLONE 20
C07AB07	Bisoprolol	BISOMBEL 10 mg
		BISOMBEL 5 mg
		BISOPROLOL BC 10
		BISOPROLOL BC 5
		BISOPROLOL EG 10
		BISOPROLOL EG 5
		BISOPROLOL RATIO
		BISOPROPHAR 10 m
		BISOPROPHAR 5 mg
		BISOPROTOP 10 mg
		BISOPROTOP 5 mg
		DOCBISOPRO 10
		DOCBISOPRO 5
		EMCONCOR
		EMCONCOR MINOR 2
		EMCONCOR MITIS
		ISOTEN
		ISOTEN MINOR
		ISOTEN MITIS
		MERCK-BISOPROLOL
C07AB08	Celiprolol	SELECTOL
C07AB12	Nebivolol	NOBITEN
C07AG01	Labetalol	TRANDATE
C07AG02	Carvedilol	DIMITONE
		KREDEX
C07BA05	Propranolol and thiazides	INDERETIC
C07BB02	Metoprolol and thiazides	LOGROTON
		SELOZIDE
		ZOK-ZID
C07BB03	Atenolol and thiazides	ATENOLOL/CHLOORT
		ATENOLOL/CHLORTA

ATC5	Lib_ATC5	Brand in Belgium
		ATEPHAR CHLOR 10
		ATEPHAR CHLOR 50
		MERCK-ATENOLOL/C
		TENORETIC MITIS
		TENORETIC-100/25
C07BB04	Acebutolol and thiazides	SECTRAZIDE
C07BB07	Bisoprolol and thiazides	EMCORETIC
		EMCORETIC MITIS
		MAXSOTEN
		MAXSOTEN MITIS
C07CA03	Pindolol and other diuretics	VISKALDIX
C07DB01	Atenolol, thiazides and other diuretics	KAL-TEN
C07FB02	Metoprolol and other antihypertensives	LOGIMAT 10
		LOGIMAT 5
		PLENDIPLUS 10
		PLENDIPLUS 5
C07FB03	Atenolol and other antihypertensives	BETA-ADALAT
		TENIF

C4 : ANTIDIABETIC DRUGS

ATC5	Lib_ATC5	Brand in Belgium
A10AD30	Combinations	LENTE MC
A10BB02	Chlorpropamide	DIABINESE
A10BB01	Glibenclamide	BEVOREN
		DAONIL
		EUGLUCON
A10BB09	Gliclazide	DIAMICRON
		MERCK-GLICLAZIDE
A10BB12	Glimepiride	AMARYLLE
A10BB07	Glipizide	GLIBENESE
		MINIDIAB
A10BB08	Gliquidone	GLURENORM
A10AB05	Insulin aspart (fast-acting)	NOVORAPID
A10AE02	Insulin (beef) (long-acting)	ULTRA-LENTE MC
A10AB01	Insulin (human) (fast-acting)	ACTRAPID HM
		ACTRAPID HM NOVOLET
		ACTRAPID HM PENFILL
		HUMAJECT REGULAR
		HUMULINE REGULAR
		HUMULINE REGULAR CARTRIDGE
		VELOSULINE HM
		VELOSULINE HUMANUM
A10AC01	Insulin (human) (intermediate-acting)	HUMAJECT NPH
		HUMULINE LONG
		HUMULINE NPH
		HUMULINE NPH CARTRIDGE
		INSULATARD HM
		INSULATARD HM NOVOLET
		INSULATARD HM PENFILL
		INSULATARD-X HUMANUM
		INSULINE INSULATARD NORDISK
		MONOTARD HM

ATC5	Lib_ATC5	Brand in Belgium
A10AD01	Insulin (human) (intermediate-acting combined w/ fast acting)	HUMAJECT 20/80
		HUMAJECT 30/70
		HUMAJECT 40/60
		HUMAJECT 50/50
		HUMULINE 20/80
		HUMULINE 20/80 CARTRIDGE
		HUMULINE 30/70
		HUMULINE 30/70 CARTRIDGE
		HUMULINE 40/60
		HUMULINE 40/60 CARTRIDGE
		HUMULINE 50/50
		HUMULINE 50/50 CARTRIDGE
		INITARD HUMANUM
		INSULINE MIXTARD NORDISK
		MIXTARD 10/90 HM NOVOLET
		MIXTARD 10/90 HM PENFILL
		MIXTARD 20/80 HM NOVOLET
		MIXTARD 20/80 HM PENFILL
		MIXTARD 30/70 HM
		MIXTARD 30/70 HM NOVOLET
		MIXTARD 30/70 HM PENFILL
		MIXTARD 40/60 HM NOVOLET
		MIXTARD 40/60 HM PENFILL
		MIXTARD 50/50 HM NOVOLET
		MIXTARD 50/50 HM PENFILL
		MIXTARD-X HUMANUM
A10AE01	Insulin (human) (long acting)	HUMULINE LONG
		HUMULINE ULTRALONG
		ULTRATARD HM
A10AB04	Insuline lispro (fast-acting)	HUMALOG
A10BA02	Metformin	DIABOMET 500 mg
		DIABOMET 850 mg
		GLUCOPHAGE
		GLUCOPHAGE 1000
		GLUCOPHAGE 850
		MERCK-METFORMINE 500 mg
		MERCK-METFORMINE 850 mg
		METFORMAX
		METFORMINE BC 500 mg
		METFORMINE BC 850 mg
		METFORMIPHAR 500 mg
		METFORMIPHAR 850 mg
A10BG03	Pioglitazone	ACTOS
A10BX02	Repaglinide	NOVONORM
A10BG02	Rosiglitazone	AVANDIA
A10BB05	Tolazamide	TOLINASE
A10BB03	Tolbutamide	RASTINON
		RASTINON 1,0
A10AA01	Insulins and analogues	ACTRAPID HM 40 U.I./ml
		DURASULINE
		HUMULINE 20/80

ATC5	Lib_ATC5	Brand in Belgium
		HUMULINE 30/70
		HUMULINE 40/60
		HUMULINE NPH
		HUMULINE REGULAR
		HUMULINE ULTRALONG
		INITARD HUMANUM
		INSULATARD HM 40 U.I./ml
		INSULINE INITARD NORDISK
		INSULINE INSULATARD HUMANUM
		INSULINE MIXTARD HUMANUM
		INSULINE MONOTARD MC
		INSULINE NOVO ACTRAPID MC
		INSULINE RAPITARD MC
		INSULINE SEMI-LENTE MC
		INSULINE VELOSULINE HUMANUM
		INSULINE VELOSULINE NORDISK
		INSULINUM NEERLANDICUM
		LENTE MC
		MONOTARD HM 40 U.I./ml
		N.P.H. INSULINE
		PROTAMINE ZINKINSULINE
		ULTRA-LENTE MC
		ULTRATARD HM 40 U.I./ml
		VELOSULINE NORDISK

APPENDIX D: DEMOGRAPHIC RESULTS

D1: MOST COMMON (FIRST 10) APR-DRG OF INDEX ADMISSIONS

MDC	APR-DRG		Percentage per severity of illness of APR-DRG			
		Total	1	2	3	4
05	190 Circulatory disorders with AMI	24317	22%	49%	18%	10%
05	174 Percutaneous cardiovascular procedures with AMI	5520	37%	41%	14%	8.0%
05	207 Other circulatory system diagnoses	2654	38%	32%	22%	8.3%
05	165 Coronary bypass without malfunctioning, with cardiac catheterization	636	0.5%	26%	47%	26%
05	191 Cardiac catheterization with circulatory disorder except ischemic heart disease	396	40%	40%	15%	5.1%
05	173 Other vascular procedures	289	3.1%	40%	30%	27%
05	175 Percutaneous cardiovascular procedures without AMI	219	36%	48%	12%	3.7%
05	170 Permanent cardiac pacemaker implant with AMI, heart failure or shock	182	7.1%	38%	32%	23%
	950 Extensive procedure unrelated to principal diagnosis	96	38%	25%	35%	2.1%
	004 Tracheostomy except for face, mout hand neck diagnoses	136	1.5%	21%	35%	43%
	TOTAL	34480	96.6%			

The table below presents counts of patients by sex and age group, for patients included or not in the Low Risk Group. These data were used to construct the population pyramids presented in the body of the report.

D2: COUNT OF PATIENTS PER SEX AND AGE GROUP

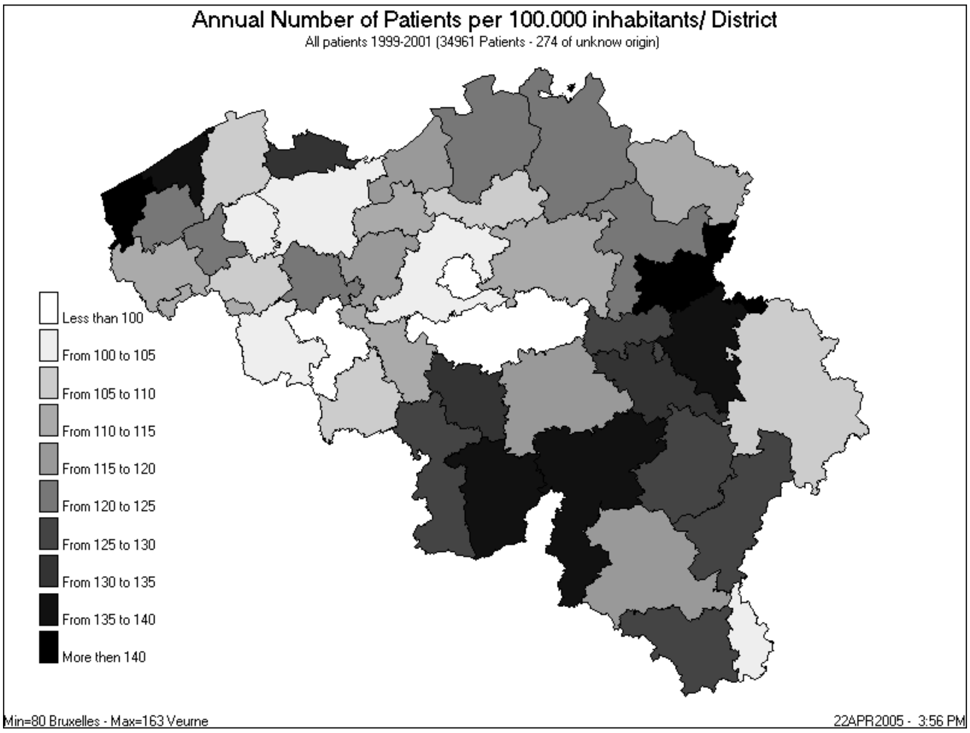
	Low Risk Group		Not in Low Risk Group		All Patients
Grpe_Age	Male	Female	Male	Female	Grand Total
GR15-19	3	1	2		6
GR20-24	5	1	1	1	8
GR25-29	32	7	4	3	46
GR30-34	121	20	18	5	164
GR35-39	319	48	80	27	474
GR40-44	766	122	207	54	1149
GR45-49	1306	243	433	82	2064
GR50-54	1669	312	740	134	2855
GR55-59	1597	290	785	194	2866
GR60-64	1645	431	1010	365	3451
GR65-69	1910	615	1448	600	4573
GR70-74	1616	789	1588	976	4969
GR75-79			3027	2269	5296
GR80-84			1567	1671	3238
GR85-89			955	1615	2570
GR90-94			311	722	1033
GR95+			51	148	199
Grand Total	10989	2879	12227	8866	34961

D3: DEMOGRAPHICS AND TREATMENTS BY AGE GROUP

Age group	N	N male	N thrombolysis first stays	N Urgent PCI	N Urgent cabg	**N reperfusion**	N Late PCI	N Late Cabg	**N revasc.**	N diabetes	N Shock	N Heart Failure	N Deceased at 1 day	N Deceased in 0/1 month	N Deceased at 1 year	N Deceased at 2 year	N w/ cardiov. history	N TL	N PCI	N CABG
<45	1847	1558	682	252	2	901	660	91	995	199	86	89	36	56	77	88	178	691	912	93
45-49	2064	1739	762	265	4	1000	824	134	1220	277	108	142	32	69	96	110	229	775	1089	138
50-54	2855	2409	1068	348	5	1367	1122	219	1676	507	171	244	51	103	149	175	387	1085	1470	224
55-59	2866	2382	1075	320	7	1353	1061	278	1648	602	219	309	59	160	218	263	401	1088	1381	285
60-64	3451	2655	1202	341	13	1501	1169	353	1851	847	331	457	108	262	350	426	587	1216	1510	366
65-69	4573	3358	1528	382	12	1874	1395	531	2288	1253	526	820	140	481	664	809	913	1551	1777	543
70-74	4969	3204	1566	316	11	1832	1259	508	2066	1483	721	1085	257	716	1050	1262	1189	1588	1575	519
75-79	5296	3027	1348	287	6	1605	1033	404	1708	1628	914	1514	349	1067	1534	1846	1277	1365	1320	410
80-84	3238	1567	642	130	3	763	343	99	572	968	609	1075	293	933	1361	1583	915	653	473	102
85-89	2570	955	389	43	0	430	109	20	171	660	498	1069	299	985	1417	1629	696	391	152	20
90-94	1033	311	116	7	0	123	20	1	28	230	179	455	164	488	670	776	257	116	27	1
>=95	199	51	15	1	0	16	2	0	3	25	24	96	28	109	145	159	56	15	3	0
TOT	34961	23216	10393	2692	63	12765	8997	2638	14226	8679	4386	7355	1816	5429	7731	9126	7085	10534	11689	2701

Age group	N	N male	N thrombolysis first stays	N Urgent PCI	N Urgent cabg	**N reperfusion**	N Late PCI	N Late Cabg	**N revasc.**	N diabetes	N Shock	N Heart Failure	N Deceased at 1 day	N Deceased in 0/1 month	N Deceased at 1 year	N Deceased at 2 year	N w/ cardiov. history	N TL	N PCI	N CABG
<45	100%	84%	37%	14%	0%	49%	36%	5%	54%	11%	5%	5%	2%	3%	4%	5%	10%	37%	49%	5%
45-49	100%	84%	37%	13%	0%	48%	40%	6%	59%	13%	5%	7%	2%	3%	5%	5%	11%	38%	53%	7%
50-54	100%	84%	37%	12%	0%	48%	39%	8%	59%	18%	6%	9%	2%	4%	5%	6%	14%	38%	51%	8%
55-59	100%	83%	38%	11%	0%	47%	37%	10%	58%	21%	8%	11%	2%	6%	8%	9%	14%	38%	48%	10%
60-64	100%	77%	35%	10%	1%	43%	34%	10%	54%	25%	10%	13%	3%	8%	10%	12%	17%	35%	44%	11%
65-69	100%	73%	33%	8%	1%	41%	31%	12%	50%	27%	12%	18%	3%	11%	15%	18%	20%	34%	39%	12%
70-74	100%	64%	32%	6%	1%	37%	25%	10%	42%	30%	15%	22%	5%	14%	21%	25%	24%	32%	32%	10%
75-79	100%	57%	25%	5%	0%	30%	20%	8%	32%	31%	17%	29%	7%	20%	29%	35%	24%	26%	25%	8%
80-84	100%	48%	20%	4%	0%	24%	11%	3%	18%	30%	19%	33%	9%	29%	42%	49%	28%	20%	15%	3%
85-89	100%	37%	15%	2%	0%	17%	4%	1%	7%	26%	19%	42%	12%	38%	55%	63%	27%	15%	6%	1%
90-94	100%	30%	11%	1%	0%	12%	2%	0%	3%	22%	17%	44%	16%	47%	65%	75%	25%	11%	3%	0%
>=95	100%	26%	8%	1%	0%	8%	1%	0%	2%	13%	12%	48%	14%	55%	73%	80%	28%	8%	2%	0%
TOT	100%	66%	30%	8%	0%	37%	26%	8%	41%	25%	13%	21%	5%	16%	22%	26%	20%	30%	33%	8%

D4: NUMBER OF AMI PATIENTS PER 100.000 INHABITANTS PER DISTRICT FOR 1999-2001



Male population

Age group	Observation years 1999-2001 (a)	N AMI patients (b)	N AMI patients without cardiovascular history (c)	AMI incidence rate (b/a*100 000)	AMI attack rate (c/a * 100 000)
GR15-19	936700	5	4	1	0
GR20-24	959172	6	5	1	1
GR25-29	1044509	36	34	3	3
GR30-34	1153109	139	129	12	11
GR35-39	1232501	399	358	32	29
GR40-44	1181299	973	887	82	75
GR45-49	1089344	1739	1545	160	142
GR50-54	1025879	2409	2078	235	203
GR55-59	786676	2382	2065	303	262

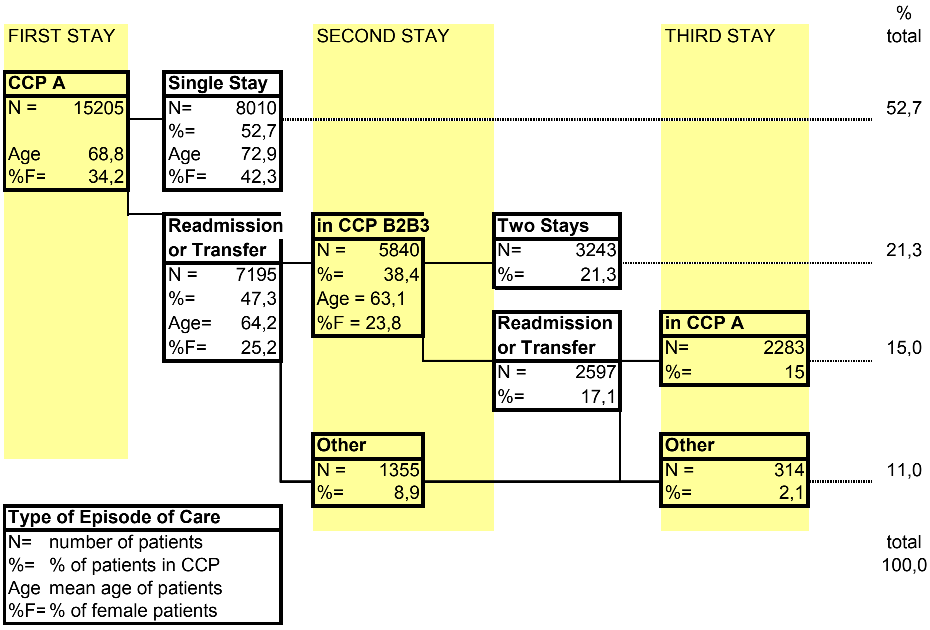
Age group	Observation years 1999-2001 (a)	N AMI patients (b)	N AMI patients without cardiovascular history (c)	AMI incidence rate (b/a*100 000)	AMI attack rate (c/a * 100 000)
GR60-64	753802	2655	2198	352	292
GR65-69	719095	3358	2682	467	373
GR70-74	604588	3204	2434	530	403
GR75-79	451746	3027	2267	670	502
GR80-84	191871	1567	1105	817	576
GR85-89	106208	955	659	899	620
GR90-94	30507	311	224	1019	734
GR95+	5283	51	36	965	681
Total	12272289	23216	18710	189	152

Female population

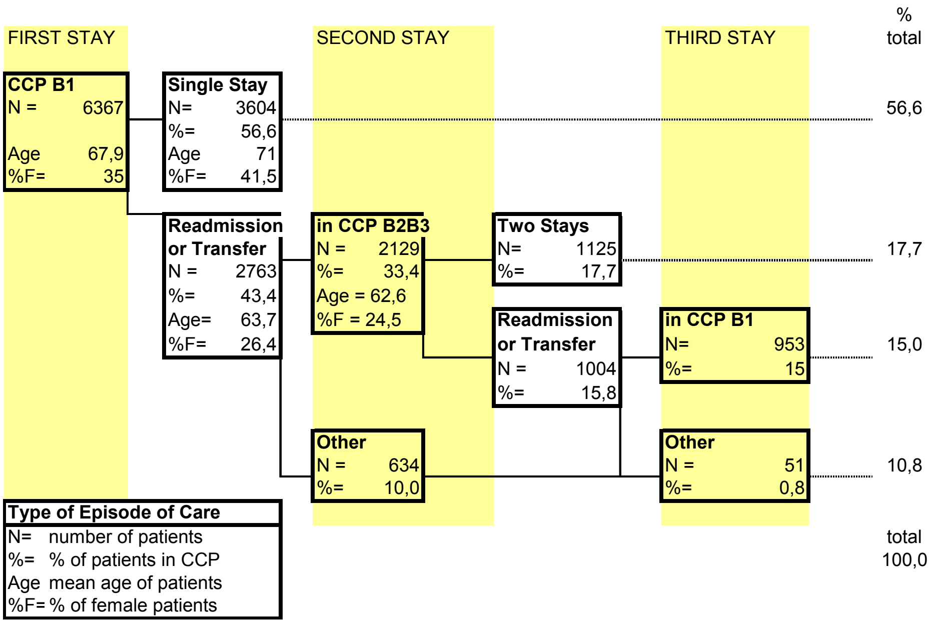
Age group	Observation years 1999-2001 (a)	N AMI patients (b)	N AMI patients without cardiovascular history (c)	AMI incidence rate (b/a*100 000)	AMI attack rate (c/a * 100 000)
GR15-19	897646	1	1	0	0
GR20-24	940174	2	2	0	0
GR25-29	1020261	10	8	1	1
GR30-34	1118288	25	23	2	2
GR35-39	1199988	75	59	6	5
GR40-44	1158744	176	159	15	14
GR45-49	1068571	325	290	30	27
GR50-54	1012045	446	390	44	39
GR55-59	799298	484	400	61	50
GR60-64	804362	796	666	99	83
GR65-69	824670	1215	978	147	119
GR70-74	778831	1765	1346	227	173
GR75-79	681581	2269	1752	333	257
GR80-84	362750	1671	1218	461	336
GR85-89	271210	1615	1215	595	448
GR90-94	111484	722	552	648	495
GR95+	26929	148	107	550	397
Total	13076832	11745	9166	90	70

D5 : TRANSFERS FOR PATIENTS BY CCP OF FIRST ADMISSION

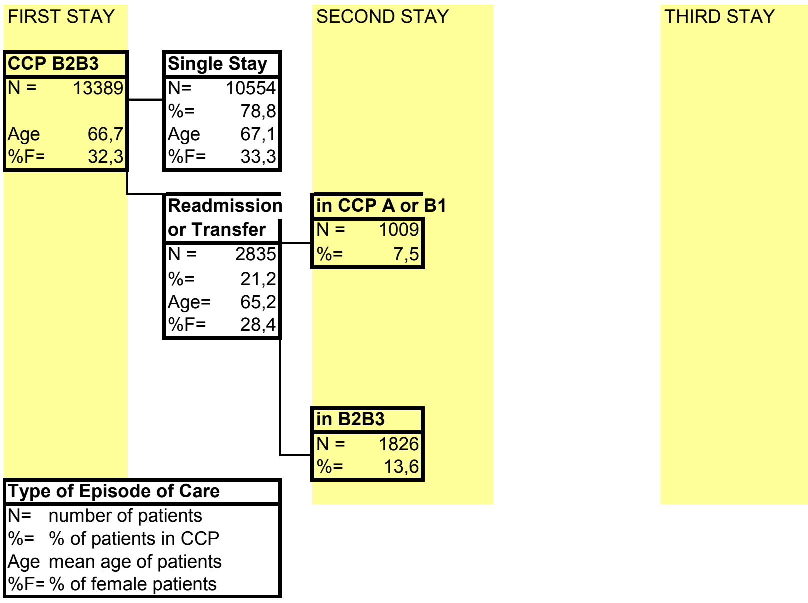
First Stay in CCP A:



First Stay in CCP B1:



First Stay in CCP B2-B3



APPENDIX E: VARIABILITY IN DIAGNOSTICS USE

E1 : CONSUMPTION INDEX COMPUTED ON SINGLE STAYS (LOW RISK GROUP)

		Consumption Index on Single stays (Low Risk Group)					
Nr Hospital	CCP	N stays	Mean_CI	Std_Var	Q1	Median	Q3
144	B1	57	**8.47**	4.08	6	8	11
116	B1	70	**7.14**	5.96	3	5	12
59	B1	59	**6.93**	5.23	3	6	10
147	B2-B3	97	**6.23**	3.93	3	6	9
52	B2-B3	157	**5.67**	4.00	2	5	9
156	B2-B3	85	**4.68**	5.12	1	3	7
148	A	24	**4.63**	3.25	2	4.5	7
79	A	40	**4.48**	3.76	1	5	7
75	A	14	**4.43**	2.38	3	5	6
149	A	33	**4.33**	1.27	4	4	5
154	A	33	**4.18**	3.30	2	4	6
129	A	38	**4.11**	2.30	2	5	6
145	B1	45	**3.91**	2.90	2	4	5
102	B2-B3	69	**3.84**	3.12	2	4	6
142	A	26	**3.62**	1.94	3	4	5
40	B2-B3	91	**3.57**	3.04	1	3	6
115	B1	42	**3.55**	2.15	2	3	5
71	B1	52	**3.48**	2.78	1	3	5
109	A	20	**3.40**	1.54	2	3	5
126	B1	66	**3.32**	2.14	1	4	5
8	A	52	**3.31**	2.04	1	4	5
95	B1	21	**3.24**	3.73	0	2	5
41	A	38	**3.24**	3.49	1	2	5
150	B1	53	**3.19**	2.50	1	3	5
48	B1	24	**3.17**	2.88	1	2	5
72	B2-B3	275	**3.03**	2.53	1	3	4
11	B2-B3	113	**2.98**	2.41	1	2	5
5	B1	33	**2.97**	1.88	1	3	4
28	B1	38	**2.87**	2.23	1	2	4
138	B2-B3	101	**2.80**	2.66	1	2	4
30	B2-B3	123	**2.72**	1.55	2	3	3
155	B2-B3	105	**2.66**	1.92	1	2	3
21	A	48	**2.65**	2.13	0	4	4
164	B1	29	**2.62**	2.06	1	2	4
66	A	25	**2.52**	2.43	1	2	3
157	A	24	**2.46**	2.32	0.5	1	4.5
114	A	35	**2.46**	1.88	1	2	4
45	A	17	**2.35**	2.45	1	2	2
88	A	22	**2.32**	1.78	1	3	4
105	B1	29	**2.31**	2.27	1	1	3
98	A	56	**2.30**	2.27	0	1.5	4
134	A	11	**2.27**	2.69	0	1	5
104	A	27	**2.15**	1.10	1	2	3
20	A	10	**2.00**	2.11	0	2	4

		Consumption Index on Single stays (Low Risk Group)					
Nr Hospital	CCP	N stays	Mean_CI	Std_Var	Q1	Median	Q3
112	A	96	1.99	1.36	1	2	3
151	B2-B3	176	1.94	1.57	1	2	3
85	A	15	1.93	1.79	0	3	4
133	B2-B3	92	1.87	1.90	1	1	3
89	A	15	1.80	1.37	1	2	3
53	B1	38	1.79	2.22	0	1	4
25	B2-B3	145	1.78	2.14	0	1	3
67	A	15	1.73	1.44	1	1	3
119	B1	92	1.72	2.04	0	1	4
163	B2-B3	238	1.63	1.22	1	1	2
121	A	29	1.59	1.68	0	1	2
19	A	65	1.55	2.33	0	1	2
106	B1	83	1.52	1.98	0	1	2
42	B2-B3	111	1.46	1.52	0	1	2
43	A	11	1.45	1.37	1	1	2
76	B2-B3	102	1.40	1.31	1	1	2
23	A	53	1.34	1.14	1	1	2
22	A	10	1.30	1.06	1	1	2
78	A	28	1.29	1.61	0	1	1
162	A	21	1.29	1.49	0	1	1
1	A	37	1.27	1.02	1	1	2
15	B2-B3	102	1.20	1.92	0	0	1
143	B2-B3	293	1.19	1.26	0	1	1
32	A	11	1.18	1.08	0	1	2
10	A	11	1.18	1.17	0	1	2
131	A	29	1.17	1.34	0	1	2
70	B2-B3	281	1.12	1.38	0	1	2
44	A	27	1.11	1.42	0	0	3
124	A	14	1.07	1.21	0	1	1
31	A	14	1.07	1.59	0	0	2
101	A	15	1.07	1.22	0	1	2
97	B1	77	1.06	1.49	0	1	1
96	A	14	1.00	1.80	0	0	1
26	A	42	0.98	1.05	0	1	1
38	A	34	0.91	1.08	0	1	1
14	A	11	0.91	1.14	0	1	1
61	B2-B3	107	0.90	1.39	0	0	1
111	B2-B3	125	0.89	1.13	0	1	1
82	B2-B3	183	0.87	1.45	0	0	1
128	B2-B3	75	0.83	1.38	0	0	1
68	A	57	0.82	1.31	0	0	2
36	A	45	0.82	1.91	0	0	1
64	A	16	0.81	0.83	0	1	1
141	B2-B3	203	0.79	1.16	0	0	1
86	B2-B3	106	0.78	1.64	0	0	1
152	A	52	0.77	1.76	0	0	0
60	A	45	0.76	1.21	0	0	1
159	B2-B3	277	0.75	1.34	0	0	1
29	A	30	0.73	1.23	0	0	1
161	B1	66	0.71	1.57	0	0	1

		Consumption Index on Single stays (Low Risk Group)					
Nr Hospital	CCP	N stays	Mean_CI	Std_Var	Q1	Median	Q3
130	A	29	0.69	1.34	0	0	1
34	A	39	0.64	0.81	0	0	1
35	A	10	0.60	0.97	0	0	1
57	B2-B3	178	0.60	0.88	0	0	1
117	A	33	0.58	1.35	0	0	0
73	A	59	0.56	0.77	0	0	1
77	B2-B3	103	0.55	1.11	0	0	1
49	A	47	0.55	0.80	0	0	1
94	A	21	0.52	1.36	0	0	0
127	B1	54	0.52	0.93	0	0	1
146	A	49	0.49	1.12	0	0	0
137	A	30	0.47	1.01	0	0	1
135	B2-B3	157	0.32	0.62	0	0	1
12	A	20	0.20	0.41	0	0	0
54	A	46	0.17	0.64	0	0	0
2	A	17	0.12	0.33	0	0	0
120	A	34	0.09	0.29	0	0	0
93	A	25	0.04	0.20	0	0	0
		Hospitals with less than 10 single stays					
56	A	9	2.56	1.74	2	2	2
153	A	9	1.11	1.17	0	1	2
50	A	9	1.89	1.69	1	1	3
99	A	9	1.67	1.22	1	2	2
47	A	7	1.71	1.70	0	2	2
107	A	7	1.14	1.68	0	0	3
69	A	7	5.43	2.82	4	5	6
13	A	5	1.40	2.19	0	0	2
139	A	5	1.00	2.24	0	0	0
140	A	5	1.60	3.05	0	0	1
39	A	5	4.80	2.05	3	4	7
9	A	4	3.25	4.03	0.5	2	6
125	A	4	1.25	1.89	0	0.5	2.5
108	A	3	2.33	1.15	1	3	3
158	A	3	1.67	2.08	0	1	4
92	A	2	8.50	6.36	4	8.5	13
17	A	1	0.00		0	0	0
46	A	1	3.00		3	3	3
7	A	1	0.00		0	0	0
136	A	1	1.00		1	1	1

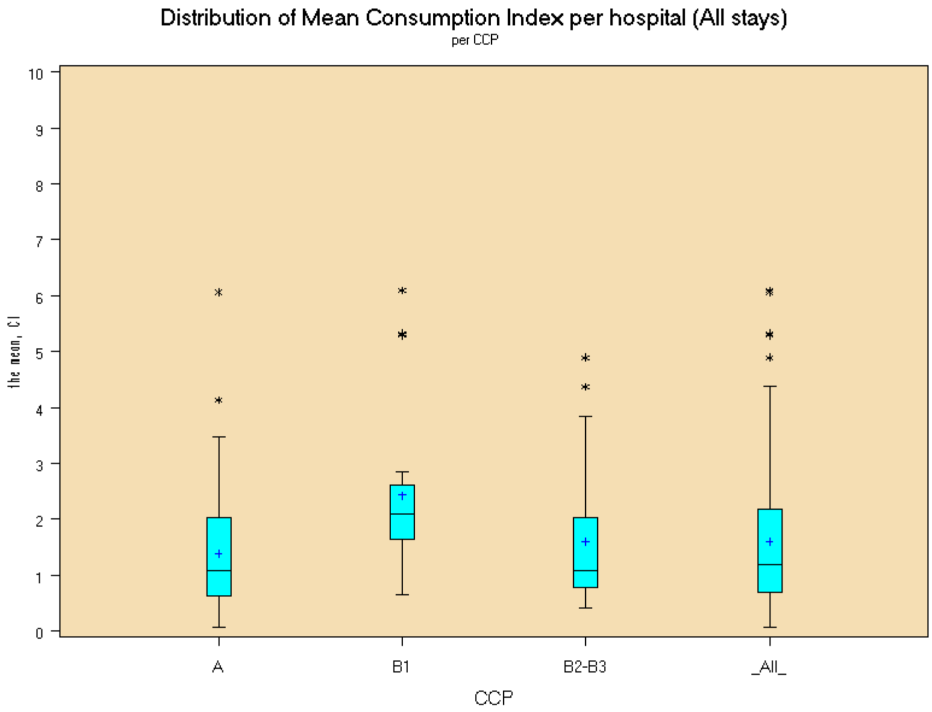
E2 : CONSUMPTION INDEX COMPUTED ON ALL STAYS (LOW RISK GROUP)

Considering all the 23376 stays of the 13868 patients in the Low Risk Group, table below shows the global results of the mean consumption index per hospital (with minimum 10 stays) as well as a differentiated result per Cardiac Care Program.

Distribution of Mean Consumption Index per Hospital (with at least 10 stays) (Low Risk Group):

CCP	Number of Hospitals	Number of stays	Mean	standard deviation	Median	Q1	Q3
A	78	8069	1.38	1.06	1.08	0.63	2.03
B1	20	3544	2.43	1.48	2.09	1.64	2.60
B2-B3	29	11711	1.60	1.25	1.07	0.78	2.02
All	127	23 324	1.60	1.23	1.19	0.68	2.19

Consumption index calculated on all stays per hospital with at least 10 stays per CCP (Low Risk Group).



Consumption index calculated on all stays per hospital per CCP (Low Risk Group).

		Consumption Index on all stays (Low Risk Group)					
Nr Hospital	CCP	N stays	Mean_CI	Std_Var	Q1	Median	Q3
144	B1	195	**6.10**	4.55	1	6	9
69	A	30	**6.07**	4.07	3	5	10
116	B1	158	**5.33**	5.54	1	3	7
59	B1	139	**5.29**	4.98	1	4	8
147	B2-B3	174	**4.90**	4.08	1	4.5	8
52	B2-B3	325	**4.37**	3.92	1	4	7
75	A	37	**4.14**	2.24	3	5	6
156	B2-B3	123	**3.83**	4.62	0	2	6
79	A	150	**3.47**	3.51	0	2	6
102	B2-B3	96	**3.40**	3.07	1	3	5
154	A	141	**3.27**	2.96	1	3	6
41	A	58	**3.14**	3.16	1	2	5
109	A	92	**3.09**	2.07	1	4	5
148	A	92	**2.98**	2.79	1	2	5
8	A	163	**2.98**	2.11	1	4	5
149	A	156	**2.90**	2.19	0	4	4.5
129	A	74	**2.88**	2.77	0	2	6
145	B1	136	**2.85**	2.88	0	2	4
138	B2-B3	128	**2.80**	2.67	1	2	4
40	B2-B3	159	**2.77**	2.91	0	2	5
11	B2-B3	181	**2.77**	2.39	1	2	4
48	B1	101	**2.66**	3.07	0	2	4
150	B1	145	**2.54**	2.44	1	2	4
46	A	15	**2.47**	2.53	0	1	4
21	A	141	**2.39**	2.19	0	3	4
142	A	73	**2.34**	2.24	0	2	4
108	A	41	**2.34**	1.78	1	2	4
115	B1	228	**2.31**	2.30	0	2	3
17	A	30	**2.23**	1.83	0	3	4
126	B1	254	**2.22**	2.24	0	1	4
9	A	15	**2.20**	2.48	0	1	4
53	B1	102	**2.19**	2.33	0	1	5
105	B1	77	**2.16**	2.35	1	1	3
121	A	99	**2.07**	2.00	0	2	4
134	A	123	**2.06**	2.00	0	2	3
114	A	89	**2.06**	1.97	0	2	4
157	A	148	**2.03**	2.07	0	1	4
71	B1	201	**2.02**	2.50	0	1	3
72	B2-B3	619	**2.02**	2.54	0	1	3
88	A	100	**2.01**	1.78	0	1	4
28	B1	136	**1.97**	2.24	0	1	3
95	B1	226	**1.94**	2.81	0	0	3
112	A	253	**1.84**	1.71	1	1	3
5	B1	435	**1.83**	1.79	0	1	3
98	A	151	**1.77**	2.17	0	1	4
66	A	85	**1.71**	1.77	0	1	2
133	B2-B3	144	**1.70**	1.97	0	1	3
119	B1	286	**1.70**	2.11	0	1	4

		Consumption Index on all stays (Low Risk Group)					
Nr Hospital	CCP	N stays	Mean_CI	Std_Var	Q1	Median	Q3
106	B1	172	**1.59**	2.22	0	1	2
85	A	150	**1.57**	1.81	0	1	3
30	B2-B3	536	**1.57**	1.46	1	1	2
104	A	67	**1.57**	1.18	1	1	3
89	A	101	**1.51**	1.68	0	1	2
25	B2-B3	242	**1.50**	2.08	0	0	3
78	A	86	**1.40**	1.55	0	1	2
151	B2-B3	457	**1.36**	1.55	0	1	2
45	A	97	**1.31**	1.77	0	1	2
155	B2-B3	520	**1.30**	1.63	0	1	2
164	B1	132	**1.29**	1.83	0	1	2
163	B2-B3	1020	**1.27**	1.33	1	1	1
19	A	233	**1.26**	1.92	0	0	2
67	A	140	**1.22**	1.34	0	1	1
36	A	123	**1.20**	2.16	0	0	2
56	A	133	**1.19**	1.49	0	1	2
23	A	173	**1.16**	1.35	0	1	2
26	A	89	**1.15**	1.73	0	1	1
47	A	67	**1.13**	1.11	0	1	2
68	A	160	**1.12**	1.56	0	0	2.5
10	A	23	**1.09**	1.59	0	1	1
152	A	235	**1.08**	1.66	0	0	3
99	A	27	**1.07**	1.07	0	1	2
42	B2-B3	344	**1.07**	1.39	0	1	1
162	A	83	**1.05**	1.51	0	1	1
97	B1	137	**1.04**	1.59	0	0	1
29	A	135	**1.04**	1.46	0	0	3
107	A	49	**1.02**	1.45	0	0	1
1	A	132	**1.01**	1.05	0	1	2
111	B2-B3	769	**0.99**	1.38	0	1	1
96	A	45	**0.98**	1.62	0	0	1
22	A	39	**0.97**	0.93	0	1	1
143	B2-B3	583	**0.96**	1.43	0	1	1
131	A	176	**0.94**	1.31	0	0	1
15	B2-B3	261	**0.93**	1.79	0	0	1
70	B2-B3	606	**0.93**	1.36	0	0	1
82	B2-B3	354	**0.92**	1.57	0	0	1
161	B1	201	**0.92**	1.78	0	0	1
158	A	11	**0.91**	1.38	0	0	1
14	A	91	**0.87**	1.18	0	1	1
86	B2-B3	147	**0.85**	1.62	0	0	1
101	A	51	**0.80**	1.13	0	1	1
32	A	66	**0.80**	1.08	0	0.5	1
20	A	49	**0.80**	1.55	0	0	0
76	B2-B3	434	**0.78**	1.24	0	0	1
34	A	146	**0.73**	1.10	0	0	1
38	A	90	**0.70**	1.09	0	0	1
50	A	44	**0.68**	1.43	0	0	1
43	A	95	**0.67**	1.12	0	0	1
61	B2-B3	390	**0.67**	1.20	0	0	1

		Consumption Index on all stays (Low Risk Group)					
Nr Hospital	CCP	N stays	Mean_CI	Std_Var	Q1	Median	Q3
127	B1	83	**0.65**	1.18	0	0	1
44	A	140	**0.65**	1.17	0	0	1
124	A	179	**0.64**	1.13	0	0	1
60	A	163	**0.63**	1.22	0	0	1
140	A	24	**0.63**	1.56	0	0	0.5
137	A	117	**0.61**	1.17	0	0	1
31	A	29	**0.59**	1.21	0	0	1
13	A	236	**0.55**	0.99	0	0	1
153	A	69	**0.55**	0.83	0	0	1
73	A	137	**0.54**	1.01	0	0	1
159	B2-B3	789	**0.53**	1.17	0	0	1
57	B2-B3	353	**0.51**	0.87	0	0	1
64	A	78	**0.50**	0.85	0	0	1
94	A	49	**0.49**	1.26	0	0	0
2	A	70	**0.49**	1.14	0	0	0
128	B2-B3	240	**0.48**	1.11	0	0	1
141	B2-B3	945	**0.48**	1.04	0	0	1
49	A	220	**0.45**	0.93	0	0	1
35	A	56	**0.43**	0.89	0	0	1
77	B2-B3	476	**0.42**	1.01	0	0	0
135	B2-B3	296	**0.42**	0.81	0	0	1
130	A	71	**0.38**	0.98	0	0	0
146	A	202	**0.28**	0.85	0	0	0
117	A	141	**0.25**	0.87	0	0	0
120	A	81	**0.21**	0.56	0	0	0
12	A	122	**0.17**	0.58	0	0	0
139	A	138	**0.15**	0.69	0	0	0
54	A	106	**0.15**	0.69	0	0	0
93	A	79	**0.08**	0.57	0	0	0
		Hospitals with less than 10 stays					
39	A	9	4.00	2.29	3	4	6
125	A	9	0.56	1.33	0	0	0
92	A	8	6.50	5.58	2.5	4	10
7	A	5	2.40	4.83	0	0	1
136	A	4	0.75	0.96	0	0.5	1.5
132	A	2	4.50	0.71	4	4.5	5
118	A	2	0.00	0.00	0	0	0
27	A	2	0.00	0.00	0	0	0
81	A	2	0.00	0.00	0	0	0
80	A	2	0.50	0.71	0	0.5	1
37	A	1	0.00		0	0	0
65	A	1	0.00		0	0	0
63	A	1	6.00		6	6	6
55	A	1	0.00		0	0	0
100	A	1	3.00		3	3	3
6	A	1	3.00		3	3	3
84	A	1	0.00		0	0	0

E3 : VARIABILITY IN THERAPEUTICS (LOW RISK GROUP).

		All Stays					Index admissions			
Nr hospital	CCP	N stays	Thrombolysis	PCI	CABG	Conservative	Thrombolysis	PCI	CABG	Conservative
163	B2-B3	1020	6.0%	69.4%	7.0%	21.5%	18.6%	68.0%	2.7%	22.9%
141	B2-B3	945	3.4%	55.4%	10.8%	32.5%	10.9%	71.8%	2.4%	22.4%
159	B2-B3	789	7.5%	72.6%	5.8%	20.0%	19.0%	74.9%	1.3%	20.3%
111	B2-B3	769	2.2%	61.2%	8.8%	28.2%	8.3%	71.8%	5.3%	20.9%
72	B2-B3	619	21.3%	69.1%	4.7%	17.8%	37.0%	60.8%	0.8%	24.6%
70	B2-B3	606	10.4%	55.6%	10.4%	29.5%	19.2%	69.2%	5.2%	17.4%
143	B2-B3	583	12.2%	50.1%	8.4%	35.3%	20.2%	53.1%	3.1%	33.8%
30	B2-B3	536	11.8%	71.8%	9.3%	14.4%	34.4%	59.6%	2.7%	24.6%
155	B2-B3	520	1.5%	51.0%	19.4%	28.5%	5.6%	58.0%	7.7%	30.1%
77	B2-B3	476	8.2%	54.2%	10.7%	30.7%	26.4%	57.4%	4.1%	24.3%
151	B2-B3	457	15.8%	64.8%	12.3%	19.3%	35.0%	70.9%	5.8%	16.0%
5	B1	435	31.3%	7.4%	0.0%	65.5%	54.8%	12.5%	0.0%	39.9%
76	B2-B3	434	14.1%	59.2%	17.1%	15.9%	39.9%	48.4%	5.2%	23.5%
61	B2-B3	390	15.4%	47.4%	12.3%	31.5%	35.9%	40.1%	4.2%	35.3%
82	B2-B3	354	22.3%	54.2%	5.1%	33.6%	34.6%	59.6%	3.1%	26.8%
57	B2-B3	353	19.8%	62.9%	7.9%	21.5%	33.2%	60.2%	1.4%	26.1%
42	B2-B3	344	4.9%	57.0%	11.3%	31.4%	11.8%	62.5%	6.9%	29.2%
52	B2-B3	325	25.5%	28.6%	5.2%	48.3%	38.1%	18.8%	2.8%	51.8%
135	B2-B3	296	20.9%	49.7%	10.5%	30.7%	29.4%	52.6%	4.3%	30.3%
119	B1	286	37.1%	11.5%	0.0%	57.0%	50.2%	15.2%	0.0%	42.7%
15	B2-B3	261	19.2%	39.8%	5.0%	41.4%	40.0%	24.0%	0.8%	46.4%
126	B1	254	29.9%	0.8%	0.0%	68.5%	43.4%	1.1%	0.0%	55.4%
112	A	253	35.2%	13.8%	0.0%	57.3%	49.2%	17.7%	0.0%	42.0%
25	B2-B3	242	19.8%	56.6%	8.7%	28.1%	26.5%	60.2%	6.1%	24.9%
128	B2-B3	240	11.7%	67.5%	11.3%	15.0%	31.1%	56.7%	7.8%	23.3%
13	A	236	22.9%	4.2%	0.0%	75.4%	40.9%	7.6%	0.0%	56.1%
152	A	235	27.2%	1.7%	0.0%	70.2%	44.4%	2.8%	0.0%	53.5%
19	A	233	49.8%	15.9%	0.0%	42.9%	58.9%	18.3%	0.0%	33.5%
115	B1	228	27.2%	2.2%	0.0%	71.5%	38.8%	3.1%	0.0%	59.4%
95	B1	226	22.6%	8.0%	0.0%	70.4%	59.3%	10.5%	0.0%	37.2%
49	A	220	31.4%	20.9%	0.0%	54.1%	42.3%	24.5%	0.0%	43.6%
146	A	202	33.2%	3.5%	0.0%	65.3%	43.5%	4.5%	0.0%	55.2%
71	B1	201	31.8%	9.0%	0.0%	64.7%	46.7%	13.1%	0.0%	48.2%
161	B1	201	45.8%	10.4%	0.0%	48.8%	54.8%	11.9%	0.0%	39.3%
144	B1	195	23.6%	3.6%	0.5%	72.3%	33.1%	2.2%	0.0%	65.5%
11	B2-B3	181	28.2%	53.6%	23.2%	17.7%	37.0%	63.8%	15.9%	12.3%
124	A	179	27.9%	3.9%	0.0%	68.7%	51.0%	6.1%	0.0%	44.9%
131	A	176	39.2%	1.1%	0.0%	59.1%	52.3%	1.5%	0.0%	47.7%
147	B2-B3	174	31.0%	44.3%	3.4%	35.6%	43.2%	44.8%	2.4%	29.6%
23	A	173	39.9%	6.9%	0.0%	56.1%	47.6%	7.6%	0.0%	49.0%
106	B1	172	45.3%	16.3%	0.0%	46.5%	60.5%	20.2%	0.0%	32.6%
8	A	163	40.5%	6.7%	0.0%	55.8%	48.5%	8.1%	0.0%	49.3%
60	A	163	30.1%	16.0%	0.0%	61.3%	43.4%	23.0%	0.0%	44.2%
68	A	160	25.0%	1.3%	0.0%	75.0%	32.0%	1.6%	0.0%	68.0%
40	B2-B3	159	8.2%	57.9%	14.5%	26.4%	12.4%	67.6%	11.4%	20.0%
116	B1	158	32.3%	0.0%	0.0%	67.7%	43.2%	0.0%	0.0%	56.8%
149	A	156	31.4%	31.4%	0.0%	49.4%	43.0%	38.6%	0.0%	35.1%
98	A	151	33.1%	7.9%	0.0%	61.6%	43.5%	10.4%	0.0%	49.6%
79	A	150	30.0%	15.3%	0.0%	60.0%	35.7%	17.5%	0.0%	54.8%

		All Stays					Index admissions			
Nr hospital	CCP	N stays	Thrombolysis	PCI	CABG	Conservative	Thrombolysis	PCI	CABG	Conservative
85	A	150	35.3%	7.3%	0.0%	56.7%	54.6%	10.3%	0.0%	39.2%
157	A	148	26.4%	2.7%	0.0%	68.9%	38.2%	3.9%	0.0%	57.8%
86	B2-B3	147	25.9%	54.4%	15.6%	21.8%	31.7%	56.7%	11.7%	21.7%
34	A	146	41.1%	4.1%	0.0%	56.2%	52.6%	3.5%	0.0%	45.6%
150	B1	145	39.3%	6.9%	0.0%	54.5%	50.4%	8.8%	0.0%	44.2%
133	B2-B3	144	17.4%	72.9%	12.5%	13.2%	24.0%	75.0%	8.7%	14.4%
21	A	141	34.0%	0.7%	0.0%	65.2%	42.5%	0.0%	0.0%	57.5%
117	A	141	42.6%	6.4%	0.0%	56.0%	60.0%	9.0%	0.0%	38.0%
154	A	141	41.8%	7.8%	0.0%	54.6%	53.6%	9.1%	0.0%	43.6%
44	A	140	34.3%	15.0%	0.0%	60.0%	52.7%	23.1%	0.0%	40.7%
67	A	140	40.0%	2.1%	0.0%	59.3%	53.3%	2.9%	0.0%	46.7%
59	B1	139	20.9%	3.6%	0.0%	75.5%	29.3%	4.0%	0.0%	67.7%
139	A	138	41.3%	2.2%	0.0%	56.5%	48.3%	0.8%	0.0%	51.7%
73	A	137	35.8%	11.7%	0.0%	59.1%	44.1%	13.5%	0.0%	50.5%
97	B1	137	38.0%	8.0%	0.0%	58.4%	44.1%	8.5%	0.0%	53.4%
28	B1	136	23.5%	3.7%	0.0%	72.8%	35.2%	5.5%	0.0%	61.5%
145	B1	136	30.9%	5.9%	0.0%	63.2%	45.2%	8.6%	0.0%	48.4%
29	A	135	23.0%	9.6%	0.0%	69.6%	33.0%	10.6%	0.0%	59.6%
56	A	133	28.6%	3.8%	0.0%	68.4%	55.9%	5.9%	0.0%	41.2%
1	A	132	38.6%	9.1%	0.0%	58.3%	52.6%	11.3%	0.0%	44.3%
164	B1	132	31.1%	3.0%	0.0%	65.9%	47.7%	4.7%	0.0%	48.8%
138	B2-B3	128	37.5%	63.3%	10.2%	19.5%	42.1%	66.7%	7.9%	17.5%
36	A	123	39.0%	20.3%	0.0%	51.2%	45.3%	20.8%	0.0%	47.2%
134	A	123	24.4%	7.3%	0.0%	70.7%	42.9%	12.9%	0.0%	51.4%
156	B2-B3	123	15.4%	32.5%	8.1%	49.6%	18.8%	36.6%	7.9%	44.6%
12	A	122	32.8%	10.7%	0.0%	60.7%	40.0%	13.0%	0.0%	53.0%
137	A	117	39.3%	10.3%	0.0%	55.6%	56.8%	13.6%	0.0%	37.0%
54	A	106	34.0%	0.0%	0.0%	64.2%	38.7%	0.0%	0.0%	61.3%
53	B1	102	32.4%	0.0%	0.0%	64.7%	43.4%	0.0%	0.0%	56.6%
89	A	101	28.7%	5.0%	0.0%	66.3%	46.8%	8.1%	0.0%	48.4%
48	B1	101	36.6%	3.0%	0.0%	59.4%	52.1%	4.2%	0.0%	45.1%
88	A	100	40.0%	2.0%	0.0%	58.0%	51.3%	1.3%	0.0%	48.7%
121	A	99	29.3%	10.1%	0.0%	63.6%	36.3%	12.5%	0.0%	55.0%
45	A	97	29.9%	7.2%	0.0%	64.9%	45.3%	9.4%	0.0%	48.4%
102	B2-B3	96	21.9%	55.2%	4.2%	34.4%	26.3%	61.3%	3.8%	27.5%
43	A	95	31.6%	1.1%	0.0%	68.4%	49.2%	1.6%	0.0%	50.8%
109	A	92	40.2%	7.6%	0.0%	55.4%	47.4%	9.0%	0.0%	48.7%
148	A	92	25.0%	10.9%	0.0%	68.5%	43.4%	18.9%	0.0%	47.2%
14	A	91	42.9%	3.3%	0.0%	54.9%	66.1%	3.4%	0.0%	32.2%
38	A	90	21.1%	4.4%	0.0%	74.4%	29.2%	6.2%	0.0%	66.2%
26	A	89	28.1%	30.3%	0.0%	57.3%	33.3%	36.0%	0.0%	49.3%
114	A	89	41.6%	3.4%	0.0%	55.1%	53.6%	2.9%	0.0%	44.9%
78	A	86	52.3%	3.5%	0.0%	45.3%	60.0%	4.0%	0.0%	38.7%
66	A	85	24.7%	1.2%	0.0%	75.3%	35.0%	1.7%	0.0%	65.0%
162	A	83	31.3%	20.5%	0.0%	57.8%	48.1%	24.1%	0.0%	42.6%
127	B1	83	25.3%	45.8%	0.0%	43.4%	30.9%	50.0%	0.0%	36.8%
120	A	81	46.9%	3.7%	0.0%	49.4%	60.3%	3.2%	0.0%	38.1%
93	A	79	48.1%	21.5%	0.0%	40.5%	56.7%	25.4%	0.0%	32.8%
64	A	78	29.5%	23.1%	0.0%	61.5%	50.0%	34.8%	0.0%	39.1%
105	B1	77	27.3%	10.4%	0.0%	64.9%	31.8%	12.1%	0.0%	59.1%
129	A	74	35.1%	36.5%	0.0%	43.2%	46.4%	44.6%	0.0%	28.6%

		All Stays					Index admissions			
Nr hospital	CCP	N stays	Thrombolysis	PCI	CABG	Conservative	Thrombolysis	PCI	CABG	Conservative
142	A	73	35.6%	2.7%	0.0%	63.0%	49.1%	3.8%	0.0%	50.9%
130	A	71	32.4%	12.7%	0.0%	59.2%	43.4%	15.1%	0.0%	49.1%
2	A	70	52.9%	4.3%	0.0%	42.9%	69.8%	1.9%	0.0%	30.2%
153	A	69	34.8%	2.9%	0.0%	63.8%	55.8%	4.7%	0.0%	41.9%
47	A	67	32.8%	1.5%	0.0%	65.7%	45.8%	2.1%	0.0%	54.2%
104	A	67	43.3%	11.9%	0.0%	52.2%	53.7%	14.8%	0.0%	40.7%
32	A	66	47.0%	3.0%	0.0%	50.0%	55.4%	3.6%	0.0%	42.9%
41	A	58	25.9%	63.8%	5.2%	27.6%	31.3%	75.0%	4.2%	16.7%
35	A	56	42.9%	3.6%	0.0%	51.8%	53.3%	2.2%	0.0%	44.4%
101	A	51	51.0%	9.8%	0.0%	47.1%	66.7%	12.8%	0.0%	30.8%
20	A	49	38.8%	6.1%	0.0%	57.1%	57.6%	9.1%	0.0%	36.4%
94	A	49	51.0%	2.0%	0.0%	49.0%	58.1%	2.3%	0.0%	41.9%
107	A	49	32.7%	2.0%	0.0%	67.3%	44.4%	2.8%	0.0%	55.6%
96	A	45	46.7%	6.7%	0.0%	51.1%	60.0%	8.6%	0.0%	37.1%
50	A	44	18.2%	4.5%	0.0%	79.5%	28.6%	7.1%	0.0%	67.9%
108	A	41	34.1%	2.4%	0.0%	65.9%	43.8%	3.1%	0.0%	56.3%
22	A	39	35.9%	7.7%	0.0%	59.0%	45.2%	6.5%	0.0%	51.6%
75	A	37	32.4%	24.3%	0.0%	54.1%	32.4%	24.3%	0.0%	54.1%
17	A	30	43.3%	0.0%	0.0%	56.7%	65.0%	0.0%	0.0%	35.0%
69	A	30	26.7%	3.3%	0.0%	70.0%	34.8%	4.3%	0.0%	65.2%
31	A	29	34.5%	10.3%	0.0%	62.1%	47.6%	9.5%	0.0%	52.4%
99	A	27	33.3%	3.7%	0.0%	63.0%	45.0%	5.0%	0.0%	50.0%
140	A	24	50.0%	0.0%	0.0%	50.0%	63.2%	0.0%	0.0%	36.8%
10	A	23	39.1%	13.0%	0.0%	52.2%	52.9%	17.6%	0.0%	35.3%
9	A	15	46.7%	0.0%	0.0%	53.3%	63.6%	0.0%	0.0%	36.4%
46	A	15	33.3%	0.0%	0.0%	66.7%	62.5%	0.0%	0.0%	37.5%
158	A	11	18.2%	9.1%	0.0%	81.8%	28.6%	14.3%	0.0%	71.4%
Hospitals with less than 10 stays										
39	A	9	22.2%	44.4%	0.0%	44.4%	28.6%	57.1%	0.0%	28.6%
125	A	9	22.2%	22.2%	0.0%	55.6%	28.6%	14.3%	0.0%	57.1%
92	A	8	12.5%	50.0%	12.5%	25.0%	33.3%	0.0%	0.0%	66.7%
7	A	5	20.0%	0.0%	0.0%	80.0%	50.0%	0.0%	0.0%	50.0%
136	A	4	0.0%	25.0%	0.0%	75.0%	0.0%	0.0%	0.0%	100.0%
27	A	2	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%
80	A	2	100.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%
81	A	2	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%
118	A	2	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%
132	A	2	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%
6	A	1	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%
37	A	1	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%
55	A	1	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%
63	A	1	0.0%	0.0%	0.0%	100.0%				
65	A	1	0.0%	0.0%	0.0%	100.0%				
84	A	1	0.0%	0.0%	0.0%	100.0%				
100	A	1	0.0%	0.0%	0.0%	100.0%				

APPENDIX F: LENGTH OF STAY

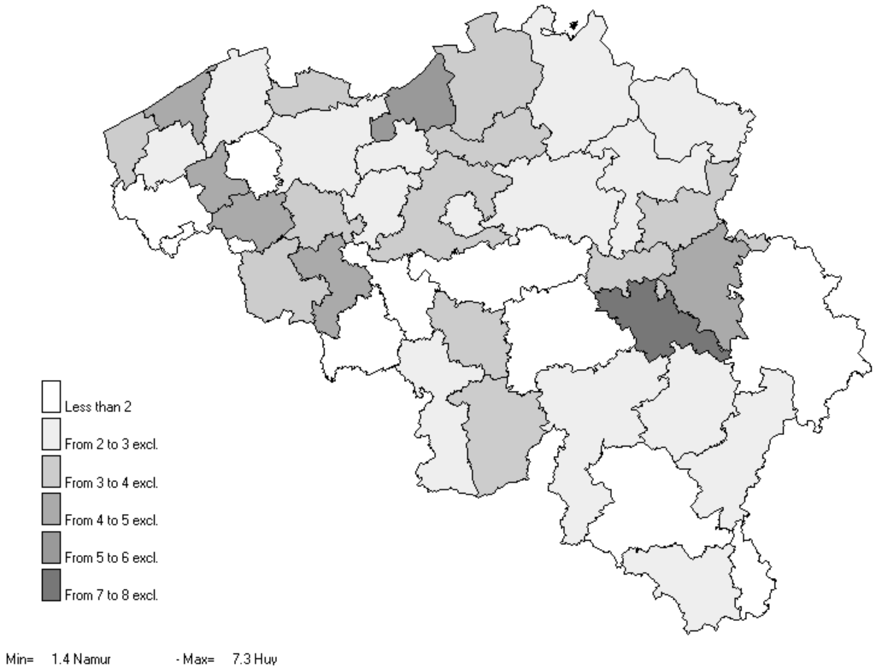
F1: SUMMARY STATISTICS ON LENGTH OF EPISODE FOR ALL PATIENTS

Subgroup	subcat	N	mean	sd	median	q1	q3	min	max
Total	Total	34961	14.2	14.2	11	7	17	1	281
Gender	Male	23216	13.2	12.5	10	7	15	1	281
	Female	11745	16.2	16.8	12	7	20	1	259
Age Group	15-49 years	3911	10.3	9.1	9	6	12	1	200
	50-59 years	5721	11.9	11.3	10	7	14	1	281
	60-69 years	8024	13.6	12.5	11	8	16	1	271
	70-74 years	4969	15.7	14.8	12	8	19	1	242
	75-79 years	5296	16.2	15.3	12	8	20	1	215
	80-89 years	5808	16.6	17.2	12	7	21	1	191
	> 90 years	1232	15.7	20.5	11	3	18	1	259
Year of Discharge	1999	11426	14.5	14.1	11	7	17	1	259
	2000	11658	14.1	14.0	11	7	17	1	281
	2001	11877	14.1	14.5	10	7	16	1	242
Cardiac History	No	27876	14.0	13.6	11	7	16	1	281
	Yes	7085	15.2	16.3	11	6	18	1	220
Diabetes	No	26282	13.1	13.0	10	7	15	1	281
	Yes	8679	17.6	16.9	13	8	22	1	271
Number of Secondary diagnoses	<= 4	18961	11.2	9.6	9	6	14	1	224
	> 4	16000	17.8	17.5	13	8	21	1	281
CCP of index admission	A	15205	14.7	14.0	11	8	17	1	271
	B1	6367	14.7	13.4	12	8	18	1	215
	B2-B3	13389	13.4	14.7	10	6	15	1	281
APR-DRG index admission	165	636	24.3	18.4	20	15	29	1	200
	174	5520	10.9	10.4	9	6	12	1	205
	190	24317	14.0	13.2	11	7	17	1	271
	207	2654	14.2	14.5	11	7	17	1	224
	oth	1834	23.0	24.9	15	9	27	1	281
Reperfusion (episode)	No	22196	14.7	15.2	11	7	18	1	281
	Yes	12765	13.4	12.2	11	8	16	1	242
Revascularization (episode)	No	20735	13.9	15.1	10	6	16	1	281
	Yes	14226	14.8	12.7	11	8	18	1	242
LOS first stay	all	34961	10.6	10.9	9	5	13	1	281
LOS second stay	all	12793	6.9	11.6	3	2	8	1	252
LOS third stay	all	4653	6.3	8.6	4	2	8	1	178
LOS fourth stay	all	884	8.3	9.5	6	2	11	1	102

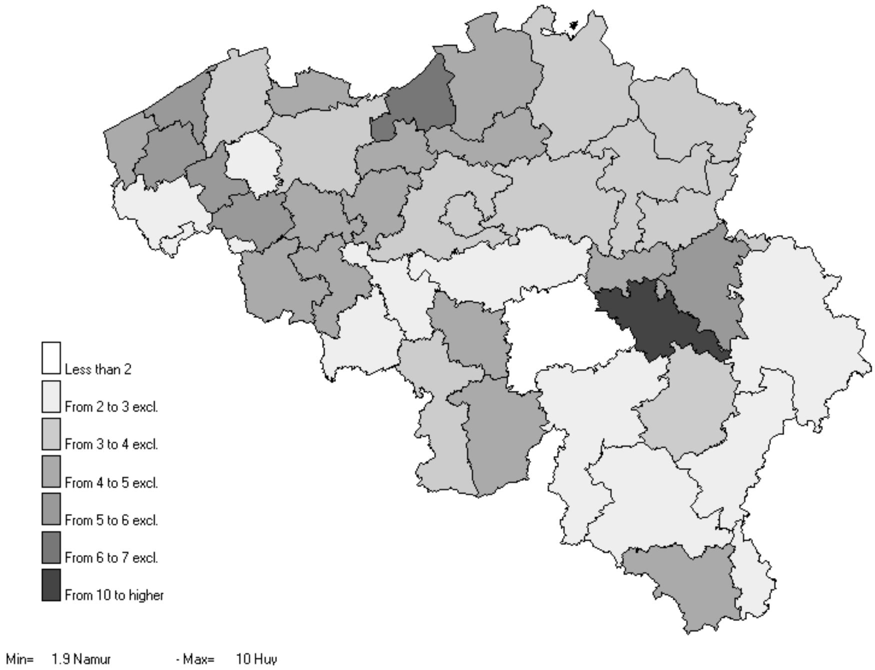
APPENDIX G: MORTALITY

G1: SHORT TERM MORTALITY (MONTH 0/1) AND ONE YEAR MORTALITY BY DISTRICT OF RESIDENCE, STANDARDIZED BY AGE AND SEX (NUMBER OF DEATHS FOR 100 000 INHABITANTS) (LOW RISK GROUP INCLUDING DEATH AT THE END OF EPISODE)

Annual number dead at 0/1 month standardized (age & sex) per 100.000 inhabitants / District
Low Risk Group 1999-2001 (14742 Patients - 152 of unknow origin /910 dec. - 13 unknow)



Annual number dead at 1 year standardized (age & sex) per 100.000 inhabitants / District
Low Risk Group 1999-2001 (14742 Patients - 152 of unknow origin /1184 dec. - 13 unknow)



G2: SURVIVAL FUNCTION (LIFE TABLE ESTIMATOR – TIME INTERVAL 3 MONTHS) ALL PATIENTS

Lower Limit	Upper Limit	Effective Sample Size	Number Failed	Number Censored	Survival	Failure	Survival Standard Error
0	3	34961.0	5878	0	1.00	0.00	0.0000
3	6	29083.0	786	0	0.83	0.17	0.0020
6	9	28297.0	492	0	0.81	0.19	0.0021
9	12	27805.0	438	0	0.80	0.20	0.0022
12	15	27367.0	401	0	0.78	0.22	0.0022
15	18	26966.0	364	0	0.77	0.23	0.0022
18	21	26602.0	331	0	0.76	0.24	0.0023
21	24	26271.0	320	0	0.75	0.25	0.0023
24	27	24922.0	343	2058	0.74	0.26	0.0023
27	30	22537.0	284	2026	0.73	0.27	0.0024
30	33	20183.0	219	2114	0.72	0.28	0.0024
33	36	17812.5	224	2189	0.71	0.29	0.0024
36	39	15440.5	205	2107	0.71	0.29	0.0025
39	42	13270.5	174	1823	0.70	0.30	0.0025
42	45	11138.5	150	2093	0.69	0.31	0.0026
45	48	8958.5	116	1967	0.68	0.32	0.0027
48	51	6912.0	88	1894	0.67	0.33	0.0028
51	54	5008.0	63	1738	0.66	0.34	0.0029
54	57	3121.5	39	1909	0.65	0.35	0.0030
57	60	1159.5	22	1937	0.64	0.36	0.0032
60	.	84.5	0	169	0.63	0.37	0.0041

APPENDIX H: MULTILEVEL STATISTICAL METHODOLOGY

To model the LOS data, a stepwise approach has been performed (as described by [47]), which fits sequentially models of increasing complexity, from an empty model (model without any covariates) to models containing both patient and hospitals covariates.

In all models below, the index i identifies a hospital and the index j identifies a patient. So Yij is the LOS of patient j in hospital i. Also, the very long stays have been truncated to 40 days (truncation of approximately 1% of data) to normalize the LOS distribution and to reduce the inflation of variance due to the presence of some outliers.

MODEL 1: EMPTY MODEL

$Y_{ij} = \beta_0 + u_i + \varepsilon_{ij}$

Model 1 is an “empty model”, i.e. a model which contains no explanatory variable. β_0 is the intercept (general mean). u_i is a random variable with mean 0 and variance σ^2_h .u_i represents the deviation from the i^{th} hospital to the general mean: hospitals with a high value of u_i tend to have, on average, high responses (longer LOS) while hospitals with low u_i tend to have, on average, low response (shorter LOS). σ^2_h represents the variability between the hospitals. ε_{ij} is a random variable with mean 0 and variance σ^2_e, which represents the variability in LOS between patients in each hospital (or within hospital variability).

In a multilevel framework, the empty model is interesting because it provides the basic partition of the variability in the data between the 2 levels in the model. This partition is given by the ICC, the intraclass correlation coefficient (ICC= $\sigma^2_h / (\sigma^2_h + \sigma^2_e)$), and is interpreted in 2 ways: it is the correlation between 2 patients in one hospital (2 patients from 2 different hospitals are not correlated), and it is also the fraction of the total variability that is due to the higher level (hospitals).

MODEL 2: MODEL WITH LEVEL 1 (PATIENT) COVARIATES

$Y_{ij} = \beta_0 + u_i + \beta_{1p}\, x_{pij} + \varepsilon_{ij}$

Model 2 is the same as model 1, with the inclusion of p level 1 (patient) explanatory variables. In our model, patient explanatory variables are the age, gender, discharge date, number of secondary diagnoses, cardiac failure and APR DRG of index admission. The 2 residual variances represent the variability that is not explained by individual patient characteristics.

MODEL 3: MODEL WITH LEVEL 1 AND LEVEL 2 COVARIATES

$Y_{ij} = \beta_0 + u_i + \beta_{1p}\, x_{pij} + \beta_{2q}\, Z_{qj} + \varepsilon_{ij}$

Model 3 is the full model, which contains both patient covariates (as described in model 2) and hospital covariates. In our model, the hospital covariates are the type of hospital (general or university) and the average volume of the hospital (based on the total number of index admissions).

In this model, β_0 is the intercept (the value obtained if all x_{pij} as well as all z_{qj} are 0), β_{1p} are the p regression coefficients of the p level 1 explanatory variables x_{pij} (patient characteristics), β_{2q} are the regression coefficients of the q level 2 explanatory variables z_{qj} (hospital characteristics).

To estimate the proportion of variance explained by the covariates, the situation is more complex than in ordinary multiple regression, where the R^2 statistic provides this measure. In multilevel analysis, one needs to distinguish between the R^2_1 and R^2_2, the proportions of explained variance by the covariates, at level 1 (between the patients) and at level 2 (between the hospitals) [79]

The first measure, $R^2 1$, is given by the proportional reduction in the value of $\sigma^2_h + \sigma^2_e$ (total variability) due to including the covariates in the model ($R^2_1 = 1 - (\sigma^2_h + \sigma^2_e) / (\sigma^2_{h0} + \sigma^2_{e0})$). R^2_2 is computed similarly (complete formulas in [79])

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Wettelijk depot : D/2005/10.273/11

KCE reports

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Inlichtingen

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